WALTER M. MATSUMOTO

REVISED BIBLIOGRAPHY ON THE CUTTHROAT TROUT

Library
NOAA, National Marine Fisheries Service
SWFC Honolulu Laboratory F/SWC2
2570 Dole Street
Honolulu, HI 96822-2396

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
RESEARCH REPORT 65

RESEARCH REPORTS

This series of reports was begun when the Fish and Wildlife Service was established in 1941; the series superseded Wildlife Research Bulletins of the Bureau of Biological Survey and Investigational Reports of the Bureau of Fisheries, those two Bureaus having merged to form the Service. The Research Reports are being continued (with Research Report 54) in a slightly changed format, as the research-reporting series of the Bureau of Sport Fisheries and Wildlife (U.S. Fish and Wildlife Service), comprising reports of scientific investigations related to the work of the Bureau. The Bureau distributes these reports without charge to official agencies, to libraries, and to researchers in fields related to the Bureau's work; additional copies may usually be purchased from the Division of Public Documents, U.S. Government Printing Office.

Current Research Reports are—

54. Fluctuations in Age Composition and Growth Rate of Cutthroat Trout in Yellowstone Lake, by Ross B. Bulkley. 1961. 31 pp.
55. Mortality Studies on Cutthroat Trout in Yellowstone Lake, by Orville P. Ball and Oliver B. Cope. 1961. 62 pp.
56. Limnology of Yellowstone Lake in Relation to the Cutthroat Trout, by Norman G. Benson. 1961. 33 pp.
57. Chemical Composition of Blood of Smallmouth Bass, by Eddie Wayne Shell. 1961. 36 pp.
58. Chronic Effects of Endrin on Bluntnose Minnows and Guppies, by Donald Irvin Mount. 1962. 38 pp.
59. Predicting Year-Class Abundance of Yellowstone Lake Cutthroat Trout, by Ross V. Bulkley and Norman G. Benson. 1962. 21 pp.
60. Limnological Organic Analyses by Quantitative Dichromate Oxidation, by John A. Maciolek. 1962. 61 pp.
61. Bioassay and Use of Pituitary Materials to Spawn Warm-Water Fishes, by Howard P. Clemens and Kermit E. Sneed. 1962. 30 pp.
62. Equilibrium Yield and Management of Cutthroat Trout in Yellowstone Lake, by Norman G. Benson and Ross V. Bulkley. 1963. 44 pp.
63. Sea-Water Systems for Experimental Aquariums; A Collection of Papers, edited by John R. Clark and Roberta Clark. 1963. 190 pp.
64. Some Chronic Effects of DDT on Cutthroat Trout, by Don Allison, Burton J. Kallman, Oliver B. Cope, and Charles Van Valin. 1963. 30 pp.
65. Revised Bibliography on the Cutthroat Trout, by Oliver B. Cope. 1964. 43 p.

REVISED BIBLIOGRAPHY ON THE CUTTHROAT TROUT

Oliver B. Cope

RESEARCH REPORT 65

UNITED STATES DEPARTMENT OF THE INTERIOR

Stewart L. Udall, *Secretary*

Frank P. Briggs, *Assistant Secretary for Fish and Wildlife*

FISH AND WILDLIFE SERVICE

Clarence F. Pautzke, *Commissioner*

BUREAU OF SPORT FISHERIES AND WILDLIFE

Daniel H. Janzen, *Director*

Published by the U.S. Fish and Wildlife Service • Washington • 1964

Printed at the U.S. Government Printing Office, Washington, D.C.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price 35 cents

CONTENTS

	Page
Introduction	1
Annotated bibliography	1
Index by subjects	34

ABSTRACT

This paper is a compilation of 221 abstracts of publications on the biology, culture, distribution, and management of the cutthroat trout, *Salmo clarki* Richardson. The 1958 publication, "Annotated Bibliography on the Cutthroat Trout," contained 135 abstracts, which have been incorporated with recent ones to form the present report.

REVISED BIBLIOGRAPHY ON THE CUTTHROAT TROUT

By Oliver B. Cope, Fishery Research Biologist

Fish-Pesticide Research Laboratory, Denver, Colorado

Bureau of Sport Fisheries and Wildlife

"Annotated Bibliography on the Cutthroat Trout" (Cope, 1958) brought together a compilation of 135 abstracts covering publications on the biology, culture, management, and distribution of *Salmo clarki* Richardson. Since 1958, several more articles dealing with the cutthroat have appeared in the biological literature. The present collection combines the abstracts published in the 1958 paper with those that have appeared through the middle of 1963.

The growing importance of *Salmo clarki* as an animal for experiment is evident from the recent references. Many studies on disease, nutrition, and pesticide toxicity are based on effects on the cutthroat, partly because of the availability of this species in areas in which these kinds of research are done, and partly because of improved cultural practices which reflect an improved understanding of the biology of the cutthroat.

Advanced investigations in the population dynamics of cutthroat, especially at Yellowstone Lake, are the subject of several recent publications. This new knowledge places fishery science in a favorable position with regard to understanding the bionomics of *Salmo clarki*.

ANNOTATED BIBLIOGRAPHY

ADAMI, J. G.

1908. On a giant-celled rhabdomyosarcoma from the trout. Montreal Medical Journal, 37(3) : 163–165.

A tumor is described from a position between the dorsal and adipose fins, off the middorsal line, on a cutthroat trout. The tumor is a giant-celled one, originating in voluntary muscle.

BACHMAN, ROGER WERNER.

1958. The ecology of four North Idaho trout streams with reference to the influence of forest road construction. Master of science thesis, University of Idaho. 97 pp.

In this study of the effects of logging on streams in Idaho, data were collected after logging for comparisons of prelogging information collected by Oien. Fish species remained as before the logging, with coastal cutthroat as the dominant form. Coefficients of condition were not lower than before logging. Length-weight relations for populations from four streams were very similar. Food habits were summarized. In general, logging did not appear to affect cutthroat populations.

BALL, ORVILLE P.

1955. Some aspects of homing in cutthroat trout. Proceedings of the Utah Academy of Science, Arts, and Letters, 32 :75–80.

Very little previous work has been done to measure the homing instinct in adfluvial fish. The U.S. Fish and Wildlife Service studied homing in the cutthroat in Yellowstone Lake from 1949 to 1955. Immatures in streams were fin clipped, and spawners in streams were tagged with Petersen disks. Results from immatures were not conclusive, but only 6 out of 280 repeat spawners returned to streams other than those in which they were originally tagged.

BALL, ORVILLE P., and OLIVER B. COPE.

1961. Mortality studies on cutthroat trout in Yellowstone Lake. U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Research Report 55. 62 pp.

In a study of the Yellowstone cutthroat trout, *Salmo clarki lewisi*, by the U.S. Fish and Wildlife Service, effects of environment on mortality of eggs, immature fish, spawners, and postspawners were measured for various components of the population in Yellowstone Lake (Wyoming). Five methods of estimating mortality of adults on spawning runs are described, with counting and tagging as the principal procedures. Of the total number of eggs deposited in the gravel, 60 to 75 percent died before hatching, and 99.6 percent had died by the time the fingerlings entered Yellowstone Lake. Among adults on spawning runs, mortality was 48.1 percent. Sex ratios on spawning runs were uneven, averaging 1.47 females to 1 male. Very few trout spawned a second time; of those that did, more spawned after a 2-year interval than after 1 year.

In the Arnica Creek runs, 48.6 percent died in the stream, 40.2 percent died later in the lake of natural causes, 7.6 percent were taken by fishermen, and 3.6 percent were alive 2 years later. The white pelican is a serious predator on cutthroat trout in Yellowstone Lake. From 1949 to 1953, fishermen caught 11.6 percent of the catchable trout available to them. Migrations of adult fish in Yellowstone Lake were traced through tagging.

BANGHAM, RALPH V.

1951. Parasites of fish in the Upper Snake River drainage and in Yellowstone Lake, Wyo. Zoologica, 36, Part 3(16) : 213–217.

Parasites of 291 Yellowstone cutthroat are listed; 278 of the fish examined were infested. Sixteen species of parasites are named, and the incidences of several are noted in discussions.

BANGHAM, RALPH V., and JAMES R. ADAMS.

1954. A survey of the parasites of freshwater fishes from the mainland of British Columbia. Journal of the Fisheries Research Board of Canada, 11(6) : 673–708.

In this study of parasites of British Columbia fishes, 178 out of 179 cutthroat from 11 locations were infested. Eighteen species of parasites were found, with trematodes, nematodes, cestodes, and acanthocephalans having the highest incidence.

BARRETT, I.

1951. Fertility of salmonoid eggs and sperm after storage. Journal of the Fisheries Research Board of Canada, 8(3)125–133.

Effects of storage on fertility of salmonoid eggs have been studied. Mature eggs and sperm were stripped into dry sterile jars and stored for varying periods at low temperatures before testing their fertility with fresh genital products. Eggs of the chum salmon, *Oncorhynchus keta*, were stored at temperatures of 2.5° to 5.8° C. for 108 hours with an average infertility of less than 20 percent. The sperm of this species shows a wide variation in its reaction to storage, but may be retained for 36 hours in sterile jars with an average of less than 10 percent infertility. Cutthroat eggs stored 36 hours were 18 percent infertile. Kamloops and cutthroat confirmed the applicability of the technique of transporting eggs and sperm stored together in the absence of water.

BEAL, FRED R.

1959. For the cutthroat, a brighter outlook. Wyoming Wildlife, 23(8) : 7–9.

Differences between Yellowstone and Snake River cutthroat are discussed. The use of cutthroat eggs of these stocks is described, and the results of planting Snake River cutthroat explained. Recent management trends in Wyoming and Idaho are discussed.

BEAN, TARLETON H.

1894a. Life history of the salmon. Bulletin of of the U.S. Fish Commission, 12 : 21–38.

The red-throated trout, *Salmo mykiss*, is called Clark's trout and Rocky Mountain trout. Discussion of distribution, food-habitat preferences, and habits is given.

1894b. Bibliography of the Salmonidae of Alaska and adjacent regions. Bulletin of the U.S. Fish Commission, 12 : 39–49.

Lists several very early papers pertaining to cutthroat trout.

BENSON, NORMAN G.

1958. Hermaphroditism in the cutthroat trout. Copeia, (3) : 239–240.

A second record of hermaphroditism in the Yellowstone cutthroat was found in 1957. The arrangement of gonads was different from that in the first record. Here, a ripe testis was found posterior to the left ovary.

1960. Factors influencing production of immature cutthroat trout in Arnica Creek, Yellowstone Park. Transactions of the American Fisheries Society, 89(2) : 168–175.

Data are presented on the variations in production of immature cutthroat trout from Arnica Creek, a tributary of Yellowstone Lake, from 1951 to 1958. Of 36,786 immature trout counted, 87.3 percent were age group 0. The highest production occurred during years when large numbers of age group 0 trout migrated downstream to Yellowstone Lake from mid-July to mid-August, or soon after they emerged

from the gravel. Ecological conditions associated with a large July–August migration were receding water levels and much light. High productions of age groups I and II trout, which are predaceous on fry, did not appear to have as much influence on the production of good year classes as did the downstream migration pattern. No relation was evident between year-class variation of immatures and reappearance of these same year classes in the spawning runs. The number of spawners or the time of the spawning run did not bear any consistent relation to the production of immatures.

1961. Limnology of Yellowstone Lake in relation to the cutthroat trout. U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Research Report 56. 33 p.

Limnological data collected from 1954 to 1959 on surface currents, temperatures, bottom soils, water chemistry, plankton, bottom fauna, and higher aquatic plants are related to the biology of the cutthroat trout, *Salmo clarki lewisi*, in Yellowstone Lake (Wyoming). The lake, formed on Eocene lava, is oligotrophic and low in dissolved solids. *Diaptomus shoshone*, *Daphnia shoedleri*, and *Conochilus unicornis* made up more than 90 percent of the macroscopic zooplankton by number. Upwelling in West Thumb was demonstrated by temperature stratification and conductivities. Plankton distribution and abundance are related to currents and water chemistry. Depth distribution, feeding, and movements of trout are related to food abundance. Trout less than 315 millimeters in total length are not caught readily because of their feeding habits and greater dispersal. There is evidence that the heavy trout harvest in the northern part of the lake allowed *Gammarus lacustris*, an important trout food, to become locally abundant.

BENSON, SETH B., and ROBERT J. BEHNKE.

1961. *Salmo evermanni* a synonym of *Salmo clarkii henshawi*. California Fish and Game, 47(3) : 257–259.

Specimens of *clarkii henshawi* from Lake Tahoe, Calif., were compared with type material of *evermanni*. It is concluded that the two are synonymous.

BIESINGER, KENNETH E.

1961. Studies on the relationship of the redside shiner (*Richardsonius balteatus*) and the longnose sucker (*Catostomus catostomus*) to the cutthroat trout (*Salmo clarki*) population in Yellowstone Lake. Master of science thesis, Utah State University. 92 pp.

The biology of longnose suckers and redside shiners in Yellowstone Lake and tributaries was studied in relation to that of the cutthroat. Interactions among species occur in lagoons and other protected areas. Suckers and shiners were not found to damage trout redds or compete with trout for spawning space. There was an overlap of food habits of juveniles and adults of all species, suggesting competition in certain areas. This competition does not appear to be great, except in younger fish. Control of suckers and shiners is suggested for management, and items for further study are pointed out.

BILTON, T. H.

1952. The creel census of cutthroat trout at Lakelse Lake, 1952. Fisheries Research Board of Canada, Progress Reports of the Pacific Coast Stations, No. 92, October: 18–20.

Three years of creel-census data were accumulated for cutthroat in the lake and river fishery in the Lakelse drainage. Lake fishing was best in July, during mayfly hatches. The river fishery had moved to the lake by this time. In August and September most of the fishing was in the lake.

The fishery was probably exploiting less than 10 percent of the catchable stock annually. A heavier fishery would obtain a higher yield, probably over a long period of years.

BILTON, T. H., and M. P. SHEPARD.

1955. The sports fishery for cutthroat trout at Lakelse Lake, British Columbia. Fisheries Research Board of Canada, Progress Reports of the Pacific Coast Stations, No. 104, November: 38–42.

Since 1950 the Fisheries Research Board of Canada has kept records on cutthroat in Lakelse Lake and Lakelse River. Notes on feeding and spawning are given. The sport fishery is described. About 2,000 cutthroat are taken annually by this fishery. Age III and IV trout have predominated in the catch each year.

Figures on the catch per unit of effort indicate that no severe depletion has occurred in the lake population, but catches on the river have declined since 1950.

Anglers have removed an average of 7 percent of the lake population annually, and 18 to 31 percent of the river population.

BJORNN, TED C.

1957. A survey of the fishery resources of Priest and Upper Priest Lakes and their

tributaries, Idaho. Idaho Fish and Game Department, Completion Report. 176 pp.

In 1955 a survey of the fishery resources of Priest and Upper Priest Lakes and their tributaries was initiated to determine the factors causing the decline in the number of cutthroat in the lake.

Streams running into the lakes provided adequate spawning sites for both cutthroat and Dolly Varden trout. In streams where brook trout have become abundant, competition for food and space between brook trout and cutthroat is very intense. Competition is less in the lakes.

Of the 93,300 fish caught in 1955 from these lakes, 10 percent were cutthroat, and of the estimated total catch of 111,400 in 1956, 5 percent were cutthroat. The average rate of catch for cutthroat in the upper lake was 1.02 fish per boat per hour, compared with 0.70 in Priest Lake. The average-size cutthroat caught in 1956 was between 11.1 and 11.2 inches. The body-scale relation appeared to be approximately linear.

Juvenile cutthroat spawned from fish migrating from the lakes were found to spend an extended period of time in the streams before migrating to the lakes. Of the fish collected from Priest Lake in 1956, 38 percent spent 2 years in the streams before migrating, 57 percent 3 years, and 5 percent 4 years. For the upper lake, 6 percent migrated after their first year, 35 percent after their second, and 58 percent after their third. The spawning season begins in April and generally ends July 1. Cutthroat in the Priest Lakes mature predominantly during their fifth year of life. Only a very small number of fish ever spawn a second time.

Diet of the cutthroat consists mainly of insects and some plankton.

An average of nearly 500,000 cutthroat a year, mostly fry, have been planted in the Priest Lake drainage for at least 10 years, but less than 1 percent have returned to the creel.

1958. The Priest Lakes fishery. Idaho Wildlife Review, 11(1) : 3–6.

The Priest Lakes are described with their fish fauna. The cutthroat fishery has declined. The life history of the cutthroat here is reviewed. Most spawners are 5 years old. The decline of the cutthroat is attributed to overfishing and competition of immatures with other species in streams. Fishing times and places are described.

1961. Harvest, age structure, and growth of game fish populations from Priest and Upper Priest Lakes. Transactions of the American Fisheries Society, 90(1) : 27–31.

Priest and Upper Priest Lakes in northern Idaho produced a catch of approximately 100,000 fish in 1956. The catch was composed of kokanee (93 percent), cutthroat trout (5 percent), and Dolly Varden and lake trout (2 percent). Three out of four fishermen were nonresidents, and a third of the hours fished were expended by anglers from more than 600 private cabins. The average rate of catch for kokanee was 2.5 fish per boat per hour on Priest Lake and 0.9 on Upper Priest Lake; for cutthroat trout it was 1.0 fish per boat per hour on the upper lake and 0.7 on Priest Lake. Juvenile cutthroat trout were found to spend 2 to 3 years in tributary streams before entering the lakes. The catch and spawning escapements of kokanee from Priest Lake during 1955 and 1956 were composed chiefly of fish in their fifth year of life.

BLACK, EDGAR C., and ISADORE BARRETT.

1957. Increase in levels of lactic acid in the blood of cutthroat and steelhead trout following handling and live transportation. Canadian Fish Culturist, Issue 20. pp. 13–23.

Alterations in the blood levels of lactic acid were investigated in hatchery-raised coastal cutthroat and steelhead trout in the following conditions: (a) After transferring from outside ponds to troughs inside the hatchery 60 yards (54.9 meters) away; (b) sham transportation run for 2 hours in tank truck; (c) holding cutthroat for 40 hours, steelhead for 16 hours, in hatchery troughs before transportation of 2 hours 50 minutes.

The following results were noted: (1) Significant increases in blood lactic acid in both species as a result of minimal handling, i.e., in transporting the fish from outside ponds to inside hatchery troughs; (2) very significant increase in blood levels of lactic acid following sham transportation run for 2 hours in a tank truck, and levels were higher in both species than those observed for lake trout and Kamloops trout in 1955; (3) storage of cutthroat for 40 hours resulted in significant lowering of blood level of lactic acid (range 0.8–17.5 mg. percent) following transportation run of 2 hours 50 minutes. Storage of steelhead trout for 16 hours before the same transportation run of 2 hours 50 minutes resulted also in a lower blood level of lactic acid (range 9.5–88 mg. percent).

BONHAM, KELSHAW, and R. WALTER WILLIAMS.

1948. Effect of population pressure upon rate of growth and food conversion of fingerling cutthroat trout. Progressive Fish-Culturist, 10(1) : 15–18.

Fingerling cutthroat trout in 80-gallon aquariums were fed equal amounts of food per fish; 2 tanks had 28 fish each, 2 had 280 fish each. Lengths and weights were determined on four occasions. Crowded fish did not differ significantly from uncrowded ones in growth rate or food-conversion rate.

BROWN, C. J. D., and CHARLES BUCK, Jr.

1939. When do trout and grayling fry begin to take food? Journal of Wildlife Management, 3(2) : 134–140.

Experiments on time of initial feeding were done for grayling and several trouts, including cutthroat. Some cutthroat fry were feeding 14 days after hatching, and all were feeding 23 days after hatching. Little uniformity between species was shown; rainbow began first, brook trout last. Size or presence of yolk sac showed no correlation with initial feeding time.

BROWN, C. J. D., and JACK E. BAILEY.

1952. Time and pattern of scale formation in Yellowstone cutthroat trout, *Salmo clarkii lewisi*. Transactions of the American Microscopical Society, 71(2) : 120–124.

Scales from adult and immature Lake Yellowstone cutthroat were studied, and three kinds of scale development noted: (1) Fish completely scaled before their first winter and with annuli on all scales; (2) fish partially scaled before the first winter, some scales without annuli; (3) fish without scales in their first winter, and with no annuli at the end of the first growing season.

BULKLEY, ROSS V.

1959. Report on 1958 fishing studies by the Bureau of Sport Fisheries and Wildlife on Rocky Mountain National Park. Rocky Mountain Sport Fisheries investigations, administrative report (mimeographed). 38 pp.

In a creel census and shocking program in waters of Rocky Mountain National Park, catch and population data were collected. Cutthroat trout were important in the catch. Growth data were calculated from scale readings, and cutthroat growth was found to be slower than other trout growth in the same waters. Surveys of high mountain lakes and streams revealed the distribution of cutthroat in the park, and gave clues to the fates of some planted fish. Stomach contents of cutthroat from some lakes and streams were tabulated and are presented in tables.

The green-back trout, *Salmo clarki stomias*, was studied in the Upper Big Thompson River. Information on length, growth, age, migration, food habits, reproduction, and sex ratios was obtained from fish captured in an upstream-downstream trap. Preliminary work was done to create a sanctuary for this rare cutthroat.

1961. Fluctuations in age composition and growth rate of cutthroat trout in Yellowstone Lake. U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Research Report 54. 31 pp.

Age composition, growth rate, and year-class strength of Yellowstone Lake cutthroat trout from collections made in 1948 and from 1950 to 1959 are analyzed to relate total catch to changes in age composition and growth rate. Catch increased from 200,015 cutthroat in 1950 to 393,467 in 1959. An increase in growth rate of fish fully recruited to the fishery and a decrease in percentages of fish belonging to age groups VI and VII are attributed to an increase in fishing pressure. Mean age of the catch varied with year-class strength, but was essentially unaffected by changes in size of the catch. Mean length of the catch has remained high, suggesting that production is more efficient now than in past years. Maximum equilibrium yield may be near.

If the catch continues to increase at the present rate, it may become excessive within the next few years.

1963. Natural variation in spotting, hyoid teeth counts, and coloration of Yellowstone cutthroat trout. U.S. Fish and Wildlife Service, Special Scientific Report—Fisheries No. 460. 11 pp.

Differences in hyoid teeth and spotting counts among samples from four related populations of Yellowstone cutthroat trout, *Salmo clarki lewisi* Girard, reached species and subspecies levels as defined by some workers. Body coloration varied significantly among fish in six spawning runs of Yellowstone Lake, Wyo. The use of coloration, spotting, and hyoid teeth counts in cutthroat trout for taxonomic purposes needs reevaluation.

BULKLEY, ROSS V., and NORMAN G. BENSON.

1962. Predicting year-class abundance of Yellowstone Lake cutthroat trout. U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Research Report 59. 25 pp.

Fluctuations in strength of year classes from 1946 to 1956 of Yellowstone Lake cutthroat from Pelican and Chipmunk Creeks are compared with the parental stock and several climatically influenced factors of the environment. Variations in year-class strength in the two tributaries were highly correlated with fluctuations in lake water levels. Strong year-classes occurred in years of low water. Female spawner escapement, timing of the runs, and summer air temperatures were not significant factors.

A formula based on water levels is presented for predicting year-class strength in Pelican Creek and in the Fishing Bridge area fishery.

Stocking of fry in years of high water is suggested as a means of supplemental natural production. A method of forecasting lake water levels several months in advance of their occurrence is discussed.

CALHOUN, A. J.

1944a. Black-spotted trout in Blue Lake, California. California Fish and Game, 30(1) : 22–42.

Upper Blue Lake is an oligotrophic lake at 8,130-foot elevation in the California Sierra Nevada. The lake has black-spotted trout which spawn in five tributary streams. Spawning time, size of spawners, and age of spawners are discussed.

In 1941 a significant number of the trout which matured sexually failed to ascend a stream to spawn.

Marked trout showed that growth did not take place after spawning, and few spawned a second time.

Heavy annual plants of small fingerlings, coupled with closure to fishing, over a 6-year period, did not increase the number of fish in the spawning runs. It seemed to lead to an overpopulation of fish and a depletion of food.

It appears undesirable to return spent spawners to a lake like Blue Lake.

1944b. The food of the black-spotted trout (*Salmo clarkii henshawi*) in two Sierra Nevada lakes. California Fish and Game, 30(2) : 80–85.

The black-spotted trout in Upper Blue Lake, a deep granite basin at 8,130-foot elevation, subsisted largely on chironomid larvae and pupae. They failed to utilize the rather abundant population of the minnow, *Rhinichthys oscula*, which competes with young trout for food.

The trout of Heenan Lake, a former grazing meadow at 7,000 feet transformed by a dam into a 25-foot-deep reservior, subsisted largely on plankton crustacea (daphnia and copepods). The extremely abundant bottom fauna of the littoral zone provided only 17 percent of their food (scuds of the *Gammarus type*) ; immature chironomids, plentiful in bottom samples, provided less than 9 percent.

Heenan Lake trout were in much better condition than those of Blue Lake, reflecting the relative richness of the two lakes.

CALIFORNIA DEPARTMENT OF FISH AND GAME.

1956. Cutthroat nursery. Outdoor California, 17(6) : 6–7, 11.

Heenan Lake, on the east slope of the Sierra Nevada in California, was built in the late twenties and stocked with cutthroat (*Salmo clarkii henshawi*) from Alpine County. The fish grew well and egg taking was initiated. California and Nevada have taken 19 million cutthroat eggs froh Heenan Lake for stocking elsewhere. California is attempting to re-establish the cutthroat in its former waters on the east slope.

CARLANDER, KENNETH D.

1950. Handbook of freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa. 281 pp.

Contains life history and biological measurements reported in many papers on cutthroat.

1953. Handbook of freshwater fishery biology with the first supplement. Wm. C. Brown Co., Dubuque, Iowa. 429 pp.

Contains life history and biological measurements reported in many papers on cutthroat.

CHAPMAN, WILBERT MCL., and ELMER QUISTORFF.

1938. The food of certain fishes of North Central Columbia River drainage, in particular, young chinook salmon and steelhead trout. Washington Department of Fisheries, Biol. Report No. 37A. 14 pp.

In this study of food eaten by several species of fishes and of efficiency of foods in producing fish, 23 cutthroat stomachs were examined. Details of diet composition are presented. The cutthroat diet was similar to that of steelhead, with insects dominating the diet.

CODE, MARK R.

1950. Cutthroat trout without dorsal fins. Progressive Fish-Culturist, 12(2) : 85–86.

Cutthroat without dorsal fins were found in South Fork of Sheep Creek in the Ashley National Forest in Utah in 1936. The coloring of the abnormal fish was darker than that of normal cutthroat in the same stream. Some fish with deformed dorsal fins were found in the same stream.

COPE, E. D., and H. C. YARROW.

1875. Report upon the collections of fishes made in portions of Nevada, Utah, California, New Mexico, and Arizona during the years 1871, 1872, 1873, and 1874. Zoology of the Wheeler Survey, 5 : 637–700.

Life history account of *Salmo virginalis*, called lake trout, brook trout, and speckled trout, with account of spawning, feeding, and movements. Angling methods are discussed. A discussion of Rio Grande trout, *Salmo spiluras* and *Salmo pleuriticus*, is presented.

COPE, OLIVER B.

1953a. Chloretone as an anaesthetic for adult cutthroat trout. Progressive Fish-Culturist, 15 (1) : 35.

Chloretone was sucessfully used for anaesthetizing adult cutthroat at Yellowstone Lake in 1952. Stock solution was prepared in the laboratory, diluted in the field, and used on cutthroat at a strength of 1 : 2,000. Cost of the chloretone is slightly higher than that of urethane.

1953b. Length measurements of Lake Yellowstone trout. U.S. Fish and Wildlife Service, Special Scientific Report—Fisheries No. 103. 17 pp.

Conversion factors and tables are given for total length, fork length, and standard length of cutthroat from Yellowstone Lake. Comparisons from year to year of average total lengths from the fishery and from spawning runs show that declines in size took place from 1950 to 1952 in the northern part of the lake, where fishing was heaviest.

1955. The future of the cutthroat in Utah. Proceedings of the Utah Academy of Science, Arts, and Letters, 32 : 89–93.

The original cutthroats in Utah, the Utah cutthroat and the Colorado cutthroat, have been replaced by the Yellowstone cutthroat. Three factors threaten the cutthroat in Utah and in other Rocky Mountain States. Construction of dams has blocked spawning runs, and more dams are planned. Rainbow are being planted in cutthroat waters and replacing the cutthroat. Importation of cutthroat eggs from Yellowstone Park has been stopped, eliminating about 45 percent of the supply to Utah.

1956. Some migration patterns in cutthroat trout. Proceedings of the Utah Academy of Science, Arts, and Letters, 33 : 113–118.

Migrating cutthroat trout spawners in Arnica Creek, Yellowstone National Park, were counted, day and night, in 1951. Five-sixths of the total count for the season entered the stream between the hours of 6 p.m. and 7–8 a.m. This nocturnal migration is unusual for salmonid spawners, and is explained by the response of spawners to evening freshets that occur during the season of melting snows.

Lakeward-migrating fry in the same stream were counted, and it was found that 88 percent of the total count from August 1 to 15 moved downstream at night. Nocturnal movements of fry have been observed in other trouts and in salmon, and have been attributed to a negative phototropism.

1957a. Six years of catch statistics on Yellowstone Lake. Transactions of the American Fisheries Society, 85 : 160–179.

Catch statistics on cutthroat in Yellowstone Lake are reported for the years 1950–55. This fishery has only one species, the Yellowstone cutthroat. Hourly distribution of fishing is unusual in that there is practically no fishing before 7 a.m. and there are three peak periods of fishing throughout the day. There is an unusual uniformity of fishing effort among days of the week. Characteristics of the various components of the fishery are described.

Reduction of the daily catch limit from five to three fish in 1953 did little toward reducing total catch, but a shortened season had a decided effect on reduction of catch.

1957b. Races of cutthroat trout in Yellowstone Lake. U.S. Fish and Wildlife Service, Special Scientific Report—Fisheries No. 208, pp. 74–84.

Yellowstone cutthroat in tributaries to Yellowstone Lake and in Yellowstone River were studied to determine the existence of races. Tagging showed the association of groups of fish with particular spawning streams, and suggests that each tributary studied has its own race of cutthroat. Migrational patterns in the lake after spawning are quite constant from year to year. Mixing of races takes place in the lake, and each part of the lake appears to contain about the same mixture each year.

Times of migration into five streams were examined for 5 years, and five different patterns were perceived. The patterns were very constant from year to year.

Differences in mean total length of fish in spawning runs were measured, and significant differences found between streams. The differences may be due to differences in age composition or in growth rate, but are racial, since the same relations occur year after year.

Sizes of eggs and numbers of eggs per female were compared in relation to sizes of

fish. Counts and measurements do not suggest that the fish are all of the same race.

1957c. The choice of spawning sites by cutthroat trout. Proceedings of the Utah Academy of Science, Arts, and Letters, 34 : 73–79.

Several environmental factors were examined in stream surveys on six Yellowstone Lake tributaries used by cutthroat trout for spawning. Attempt was made to relate distribution of redds in each stream with factors known to sometimes influence choice of spawning sites. Distribution of the best gravel and presence of waterfalls, log jams, and chemical barriers can account for distribution of nests in most of the streams. No explanation is at hand, with our limited knowledge, to reveal why more spawning did not take place in upstream areas in Chipmunk Creek; spawners shunned what seemed to be ideal spawning territory in middle stretches and used lower sections.

Influences of forest cover and stream gradient on distribution of spawning in streams were studied, but no effects were apparent.

A theory applying to use by migrating spawners of headwater areas by the first part of the migration and downstream sections by the later parts of the run was examined in the light of experience with cutthroat in these streams. Arnica, Chipmunk, and probably Pelican Creek fish support the theory; Clear Creek fish were the only ones appearing to refute the hypothesis.

1958a. Annotated bibliography on the cutthroat trout. Fishery Bulletin of the U.S. Fish and Wildlife Service, 58(140) : 417–442.

Publication of articles on the cutthroat trout began before the turn of the century, after exploration in the intermountain region had brought several forms of the cutthroat trout to the attention of fishery workers. The present compilation brings together 135 abstracts of papers which deal with the biology, culture, distribution, and management of the cutthroat. Twenty-seven zoological names proposed for the cutthroat are listed, and 70 vernacular names, taken from the literature, are presented.

1958b. Incidence of external parasites on cutthroat trout in Yellowstone Lake. Proceedings of the Utah Academy of Science, Arts, and Letters, 35 : 95–100.

Fish and Wildlife Service biologists determined some features of the external parasites on *Salmo clarki lewisi* in Yellowstone Lake. They counted and tabulated numbers of copepods (*Salmincola* sp.) and leeches (*Piscicola salmositica*) on 10,700 cutthroat trout in the 1956 and 1957 spawning migrations out of Yellowstone Lake. Comparisons of incidence of copepods, using analysis of variance and *t* tests, showed that statistical differences in degree of parasitism in 1957 did occur, and the Arnica Creek fish were more heavily infested than fish from other streams. With respect to the leeches, Arnica Creek fish also showed significantly greater numbers than those in four other tributary streams.

Arnica Creek fish showed no statistical difference in numbers of copepods or leeches between 1956 and 1957. Comparisons of parasitism on host sexes showed that male cutthroat bore more copepods then did females, but female trout had more leeches than did males.

Trout on the upstream migration in Arnica Creek bore more copepods and leeches than did the same fish moving downstream after spawning. It is supposed that many parasites were rubbed off the hosts during spawning.

Copepods in all streams were most abundant at the beginnings and ends of the trout migrations; the smallest numbers were found in the middle of the season. In three streams, greatest leech incidence was noted at the beginnings of the migrations with no leeches after the middle of the runs; one stream had the greatest leech density on its fish at the end of the season.

1961. Effects of DDT spraying for spruce budworm on fish in the Yellowstone River system. Transactions of the American Fisheries Society, 90(3) : 239–251.

DDT was sprayed at 1 pound per acre from airplanes for the control of spruce budworm on 71,678 acres in the Yellowstone River drainage in 1957. Stream-bottom invertebrates were reduced in number immediately after the spray. Recovery to near-normal total numbers occurred within a year in most streams, but species composition was altered. Drift samples in one stream showed dead and dying invertebrates to be drifting in the current in great numbers. No mortality to fish was found. Chemical analysis showed that DDT up to 0.03 p.p.m. was in several samples of water from streams. In one case a trace was found 55 miles downstream from the spray area. Vegetation samples contained up to 2.3 p.p.m. of DDT. All of the 80 samples of mountain whitefish (*Prosopium williamsoni*), cutthroat, rainbow, and brown trout (*Salmo clarki, Salmo gairdneri, and Salmo trutta*) analyzed contained either DDT up to 14.0

p.p.m. or DDE up to 6.54 p.p.m., or both. DDT was found in trout 85 miles below the spray area, and fish taken more than 2 years after spraying contained DDT.

CORDONE, ALMO J., and DON W. KELLEY.

1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game, 47(2) : 189–228.

This is a review of investigations on the effects of inorganic sediment on the aquatic life of streams. The direct effect of sediment upon fishes, the influences of sediment upon eggs and alevins, bottom organisms, aquatic plants, chemical and physical characteristics, and fish habitat and fish populations are discussed. Studies on cutthroat trout are reviewed and discussed in the light of effects of sediment It is concluded that sediment is detrimental to aquatic life in salmon and trout streams.

CRAMER, FREDERICK K.

1940. Notes on the natural spawning of cutthroat trout (*Salmo clarkii clarkii*) in Oregon. Proceedings of the Sixth Pacific Science Congress of the Pacific Science Association, 3 : 335–339.

This study at Alsea Hatchery in Oregon was concerned primarily with spawning activities of coastal cutthroat. Time of spawning: spawning migrations were counted from December 5, 1938, to February 17, 1939, indicating a peak in late November and early December. Time of hatching: eggs hatch in 45–50 days. Nature of gravels and nests: eggs were 4 to 7 inches deep in pea-size gravel. Spawning activity: spawning day and night. Spawning was completed in 2 days. More than one nest per female was built. Eggs removed from nest: proportion of fertile live eggs 90 percent and better at stages up to 17 days. Egg counts: 2-year-old hatchery trout averaged 372.5 eggs per female. Small, wild, resident cutthroat averaged 480, and large, sea-run cutthroat averaged 1,170 eggs per female. Sex ratio: 52 males to 48 females in the spawning run.

DANIELS, T. W.

1952. Two-Ocean Pass, Wyoming. Wyoming Wildlife, 16(6) : 4–8.

Two-Ocean Pass, on the Continental Divide in Wyoming, is described geographically, and historical significance of fishing studies there is discussed. This was the route used by cutthroat to enter Yellowstone Lake from the Snake River, according to the author, who cites Evermann.

DAVIS, H. S.

1947. Care and diseases of trout. U.S. Fish and Wildlife Service, Research Report 12, Third Revision. 98 pp.

Care of trout at the hatchery, including care of ponds and raceways, is treated at some length. This is followed by general discussion of trout foods and methods of feeding, special attention being paid to use of dry products for supplementing fresh meat in the diet. Some consideration is given improvement of brood stock and its practical value.

General discussion of parasites and diseases of trout and their control is followed by detailed account of each disease, including characteristic symptoms, etiology, pathology, and methods of control. Figures include drawings and photomicrographs of the most important organisms that cause trout diseases and their effects on tissues.

Numerous examples of care and diseases of cutthroat trout are used in this report.

1953. Culture and diseases of game fish. University of California Press, Berkeley and Los Angeles. $x+332$ pp.

Cultural methods applicable to cutthroat and other trouts are discussed, and diseases and parasites, some of which occur in cutthroat, are taken up in detail.

DEWITT, JOHN W., Jr.

1954a. A survey of the coast cutthroat trout, *Salmo clarki clarki* Richardson, in California, California Fish and Game 40(3) : 329–335.

Distribution of coastal cutthroat in California, morphology, life-history notes, and age distribution are discussed.

1954b. A survey of private trout enterprises in the west. Progressive Fish-Culturist, 16(4) : 147–152.

This paper deals with types of trout businesses, status of ownership, length of time in business, investment and income, egg and trout production, and important general problems in private trout production. Cutthroat trout production in Western States is listed in tables.

DIMICK, R. E., and DON C. MOTE.

1934. A preliminary survey of the food of Oregon trout. Oregon State College, Agricultural Experiment Station, Bulletin 323. 23 pp.

Insects are the dominant food of cutthroat and rainbow trout in Oregon. Aquatic insects are the bulk of the food. Terrestrial insects are prominent in diet in spring, summer, and fall. Crayfish, small fish, and pieces of dead salmon are important to large trout, while

immatures of blackflies and midges are important to small trout in streams. Small trout in lakes eat mainly immature midges and water fleas. Fresh-water shrimps are important to Oregon trout in lakes. Table II has detailed analysis of food of 326 cutthroat trout.

DIMICK, R. E., and FRED MERRYFIELD.

1945. The fishes of the Willamette River system in relation to pollution. Oregon State College, Engineering Experiment Station, Bulletin 20. 58 pp.

Details of distribution of coastal cutthroat in this drainage are given. Two biological phases of the cutthroat are reported for the Willamette system. One is nonmigratory and does not get down to the main stem. The other is migratory and gets at least down to the main stem, and perhaps to the ocean. Migratory fish are larger, growing to 18–20 inches. Spawning and feeding habits are discussed. Relations to pollution are treated.

DONALDSON, LAUREN R., and FRED J. FOSTER.

1938. A summary table of some experimental tests in feeding young salmon and trout. Transactions of the American Fisheries Society, 67 : 262–270.

Tables contain many references to diets fed to cutthroat, and effects on the fish.

DONALDSON, LAUREN R., DONALD D. HANSLER, and TERRY N. BUCKRIDGE.

1957. Interracial hybridization of cutthroat trout, *Salmo clarkii*, and its use in fisheries management. Transactions of the American Fisheries Society, 86 : 350–360.

Two races of coastal cutthroat trout (*Salmo clarkii*) were hybridized, and resultant first generation hybrids were compared with parent races. In both laboratory and field studies the hybrids showed evidence of hybrid vigor. Catch of sport fishermen, during two seasons at Echo Lake in Washington, where both parent and hybrid trout were planted, was composed of 3 to 6 times as many fish of hybrid stocks as of parent races.

DRUMMOND, ROBERT A., and HOWARD A. TANNER.

1960. Reproduction and harvest of cutthroat trout at Trappers Lake. Colorado Cooperative Fishery Research Unit, 7 : 1–19.

Yellowstone and Colorado River cutthroat were studied in Trappers Lake. Numbers of spawners were determined, and Colorado River trout were 3.5 times as abundant as Yellowstone cutthroat. Production of fry was estimated. A total of 25,780 hours of fishing removed 11,601 trout from the lake.

DYMOND, J. R.

1928. The trout of British Columbia. Transactions of the American Fisheries Society, 58 : 71–77.

Description of cutthroat is given, with notes on distribution. Suggestions for management are advanced.

1931. Description of two new forms of British Columbia trout. Contributions to Canadian Biology and Fisheries N. S., 6(16) : 391–395.

Kamloops and cutthroat trout found at high altitudes in British Columbia differ in so many respects from those occurring at lower levels that it has been found advisable to recognize them as subspecifically distinct. Two new subspecies are therefore described, viz., *Salmo kamloops whitehousei* and *Salmo clarkii alpestris*.

1932. The trout and other game fishes of British Columbia. Canada Department of Fisheries, Ottawa, 51 pp.

Structural and color details of cutthroat in British Columbia are described. *Salmo clarkii clarkii*, *S. c. lewisi*, and *S. c. alpestris* are subspecies treated, and a hybrid between Kamloops and cutthroat is briefly discussed. Excellent color plates of coastal and Yellowstone cutthroats are included. Descriptions and life histories include colorations, morphologies, migrations, spawning, and game-fish qualities. Comparisons with steelhead are made for the coastal form.

ECHO, JOHN B.

1956. Some ecological relationships between yellow perch and cutthroat trout in Thompson Lake, Mont. Transactions of the American Fisheries Society, 84 : 239–248.

Relation between yellow perch and cutthroat trout in Thompson Lake in Montana was investigated in summers of 1952 and 1953. These lakes originally contained cutthroat trout and were later planted with yellow perch. Spawning time of yellow perch was in early May, of cutthroat trout in late May. The population of yellow perch was large, and growth was very slow. Although number of cutthroat trout was small, growth rate for this species was about average. Food of yellow perch was largely immature aquatic insects and plankton, while that of cutthroat trout was mostly mature aquatic insects and small perch. Yellow perch were commonly distributed along lake margins, and concentrations of perch fry and adults were found in these areas in spring. During this period

the salmonid fishes were predominantly in deep water. Spot poisoning of yellow perch concentrations practically destroyed all fish in the treated area. Management suggestions are given.

ELLIS, MAX.

1914. Fish of Colorado. University of Colorado Studies, 11(1) : 1–136.

General discussion of trouts in Colorado; specific treatments of distributions and appearances of *Salmo c. spilurus*, *S. c. pleuriticus*, *S. c. stomias*, and *S. c. macdonaldi*.

EVERMANN, BARTON W.

1893. A reconnaissance of the streams and lakes of western Montana and northwestern Wyoming. Bulletin of the U.S. Fish Commission, 11 : 3–60.

Deals with natural-history features of trout streams and distribution of fishes, as well as requirements for fish-cultural stations. Distributional and descriptive notes on *S. mykiss* are given.

EVERMANN, BARTON W., and E. L. GOLDSBOROUGH.

1907. The fishes of Alaska. Bulletin of the U.S. Bureau of Fisheries, 26 : 219–360.

Discussion of distribution of cutthroat trout in Alaska, description of the fish and comparison with rainbow, and fishing methods. Excellent colored plate.

FISH, FREDERIC F.

1934. Ulcer disease of trout. Transactions of the American Fisheries Society, 64 : 252–258.

Lesions of a type like furunculosis were noted on fingerling cutthroat, brook, rainbow, and lake trout and were caused by *Proteus hydrophilus*. Gross and microscopic pathology are described, and control is discussed. Photograph of lesions on cutthroat.

FLEENER, G. G.

1952. Life history of the cutthroat trout, *Salmo clarki* Richardson, in Logan River, Utah. Transactions of the American Fisheries Society, 81 : 235–248.

This study of cutthroat trout in Logan River, Utah, was based on 306 specimens collected during 1948 and 1949 with an alternating-current electric shocking machine. Cutthroat trout comprised 24 percent of the anglers' catch in 1948 and 31.5 percent in 1949. The greatest numbers were found in areas with a high stream gradient. An estimated minimum number of 43.6 pounds of cutthroat per acre and 565 fish per mile was obtained from a series of shocking operations in 1949. Scale analysis was employed in determining age of the fish. With a scale magnification of 50 X, the body-scale (L/S) relation of cutthroat trout can be described as a curvilinear regression line, and expressed by the equation $L = 3.411S^{1.2006}$.

Smallest average annual growth increment was 53 millimeters. This was based on a growing season of approximately 200 days. Growth began in latter part of March and extended to early October.

Relation between standard length and weight was expressed mathematically as $W = 4.344 \times 10^{-5} L^{2.8253}$ where W equals weight in grams and L equals standard length in millimeters. Coefficient of condition decreased as length of fish increased. Male cutthroat trout had slightly more weight per unit of length than females. Of 142 fish marked with jaw tags, 15 were recovered; 9 moved out of the 0.1-mile area where they were released. Spawning period of cutthroat trout in this area lasted from early April to middle of August, but most fish spawned before middle of July. Adult females ranged in size from 11 inches downward. Slightly more females were present in a total of 35 separate collections.

Insects were the main item in diet of Logan River cutthroat trout. Ephemeroptera, Trichoptera, and Diptera were principal aquatic orders taken, while most important terrestrial order was Coleoptera. Small numbers of fish eggs eaten indicated that survival was not affected. Only two occurrences of fish were found in the entire food habits study. Small size of cutthroat trout in this area is in part attributable to almost total absence of forage fish in upper Logan River.

FOSTER, FRED J.

1933. Life histories and environmental needs of native and introduced fish. In "Game Management Developments and Needs," Utah State Agricultural College, Miscellaneous Publication No. 10. pp. 5–9.

Relations between cutthroat in Utah and introduced yellow perch are discussed. Kinds of cutthroat present in Utah, spawning conditions, characteristics of eggs and hatching habits of fry are presented. Causes of mortality are listed as nonfertilization, high water, and natural enemies. Life history of yellow perch is briefly discussed. Environmental needs of cutthroat are noted—character of water, food, and proper spawning conditions.

GARD, RICHARD.

1953. A taxonomic study of the rainbow trout populations of the streams on Mount St. Gorgonio, San Bernardino County, Calif.

Master of arts thesis, University of California. 59 pp.

This study was undertaken to determine if *Salmo evermanni* still existed in pure form. Several morphological features are correlated with type of environment. Given are: description of collecting areas, status of populations, sampling methods, comparisons of characteristics, effects of stocking. It is concluded that *S. evermanni* is not present in the area, and this is attributed to stocking with rainbow.

GEE, MERLE A.

1940. Report on the Upper Pecos River creel census, Santa Fe National Forest. Transactions of the Fifth North American Wildlife Conference. pp. 207–217.

A creel census was conducted in 1939 in the Upper Pecos River. Brown, rainbow, and Yellowstone cutthroat trout were the species caught. Brown trout, naturally reproduced, were the most abundant in the creel. Rainbows, stocked and naturally reproduced, were next in numbers in the creel. Cutthroat, planted and naturally reproduced, comprised only 9.18 percent of the catch. The cutthroat catch peaked in August, possibly as a result of midsummer recruitment. The 6- to 8-inch size class of cutthroat was the most important class.

1942. Success of planting legal-sized trout in the Southwest. Transactions of the Seventh North American Wildlife Conference. pp. 238–245.

Plants of legal-sized rainbow and cutthroat trout were made from 1939 to 1941, and in spring, summer, fall, and winter plantings. Returns for the two species were generally comparable, with returns from 37.3 to 58.8 percent from spring and summer plantings. Best returns were from releases just before opening of fishing season and during the season. Overwintering of planted fish was poorer than with wild fish.

GILBERT, CHARLES H., and BARTON W. EVERMANN.

1894. A report upon investigations in the Columbia River Basin, with descriptions of four new species of fishes. Bulletin of the U.S. Bureau of Fisheries, 14: 169–204.

Discusses morphology of various subspecies of cutthroat in this drainage and others.

GRASSE, JAMES E.

1949. Beaver and trout. Wyoming Wildlife, 13(11): 4–13.

Review of work on beaver-trout relations is given. Beaver in Wyoming are discussed, and the place of cutthroat and brook trout in relation to these species is treated. The author concludes that beaver ponds are beneficial to trout in Wyoming, and that the brook trout is the beaver-pond trout in that State.

GREENE, WILLIAM S., Jr.

1937. Colorado trout. Colorado Museum of Natural History, Popular Series, No. 2. 48 pp.

Contains sections on *Trutta pleuriticus*, *T. virginalis*, *T. macdonaldi*, and *T. stomias*, with treatments on identification, distribution, and biology.

GRIFFIN, L. E.

1938. Experiments on the tolerance of young trout and salmon for suspended sediment in water, In "Placer mining on the Rogue River, Oreg., in its relations to the fish and fishing in that stream." Oregon Department of Geology and Mineral Resources, Bulletin 10, Appendix B: 28–31.

Experiments were performed to learn the direct effects of soil sediment in water on fish. The fish were 2- to 2½-inch cutthroat trout and young chinook salmon. Some cutthroat were held in troughs and 2,300 to 3,500 p.p.m. of sediment was added to the flowing water; other cutthroat were held in clear water. The fish in clear water were nervous during the experiment, while those in cloudy water were bold. After 2 weeks, 56 percent of the trout in the cloudy water were alive; 10 percent of the control fish were alive. With salmon, in water containing 3,100 to 6,500 p.p.m. of sediment, 88 percent were alive after 28 days; control salmon had a 36 percent survival in the same time. The experiment shows that cutthroat trout and chinook salmon can live in muddy and opaque water, and can feed and grow well in very muddy water.

GRIFFITHS, FRANCIS P., and ELDEN D. YOEMAN.

1940. A comparative study of Oregon coastal lakes from a fish management standpoint. Proceedings of the Sixth Pacific Science Congress of the Pacific Science Association, 3: 323–333.

Oregon Game Commission studied certain coastal lakes in Oregon to compare productivity and to find a brood lake for coastal cutthroat. Geographical and climatological features of the lakes are discussed, fish faunas of 10 lakes are listed, and their limnology treated. Food of cutthroat of the lakes is composed mostly of insects. Condition factors ranged from 41.67 to 69.47. Suggestions for management of the lakes are presented.

HAGEN, HAROLD K.

1958. A case for the native. Wyoming Wildlife, 22(9): 31–37.

This article describes the dominance of rainbow and brook trouts over the cutthroat in the Rocky Mountain region. The life history of the cutthroat is described in detail.

HAIG-BROWN, RODERICK L.

1939. The western angler—an account of Pacific salmon and western trout. Derrydale Press, New York. 200 pp.

Good account in nontechnical language of biologies and life histories of cutthroats in British Columbia. Chapter on coastal cutthroats describes migrations in detail, and another on nonmigratory cutthroat contains a great deal of valuable material on habits.

HALL, E. RAYMOND.

1924. Pelicans versus fishes in Pyramid Lake. Condor, 27 : 147–160.

Importance of cutthroat trout of Pyramid Lake is discussed, and the decline of commercial and sport fisheries is described. Investigation of white pelicans in relation to cutthroat was begun in 1924. Food habits of pelicans and their feeding behavior in herding trout are treated. Red suckers, lake minnows, lake chubs, carp, Sacramento perch, and catfish were taken by the pelicans, as well as cutthroat up to 8 pounds. Trout were considered accidental food items. It is concluded that the white pelican is not detrimental to fishing industry, although local people believe it eats large numbers of cutthroat. Decline of trout is blamed on depletion of water, as well as on a dam, diversions, and pollution.

HALL, MAURICE C.

1930. Report on parasites of pelican and trout investigations at Yellowstone Lake, 1930. Unpublished report in Yellowstone Museum. 10 pp.

Studies on tapeworms in cutthroat and pelicans featured postmortem examination of pelicans for parasites and antihelminthic treatment of pelicans. Pelicans are freed from tapeworms with kamala. Relation between fish size and parasitism is discussed, as is the relation between parasitism and reduced cutthroat egg production. Antihelminthic treatment of pelicans is recommended as a control for tapeworms in Yellowstone Lake cutthroat.

HAMMER, GLEN L.

1960. Toxicity of pyridylmercuric acetate to cutthroat trout. Progressive Fish-Culturist, 22(1) : 14.

Two-year-old Snake River cutthroat were treated for 1 hour with PMA at a concentration of 1 : 500,000 and returned to rearing tanks. The treatment was repeated the next day. Two hours after the second treatment they were in distress and mortality was 24 percent after 24 hours.

Brown, brook, rainbow, and cutthroat, 3 to 18 inches in length, were then given the same treatment, the larger cutthroat being survivors from the first test. After 3 days, the lake, brown, brook, and larger cutthroat showed 100 percent survival. Cutthroat fingerlings suffered almost 25 percent mortality.

HANZEL, DELANO A.

1961. The distribution of the cutthroat trout (*Salmo clarki*) in Montana. Proceedings of the Montana Academy of Sciences, 19 : 32–71.

A study was made to determine distribution and relative abundance of pure cutthroat trout stocks in Montana and to secure information on factors that influence distribution and abundance. Observations were also made on taxonomic differences between strains and on the prevalence of hybrids. Barriers in relation to cutthroat distribution were noted. Exotic fish planted above barriers were predominant. Details of distribution of cutthroat and other fish are given in tabular form for hundreds of Montana lakes and streams.

HARTMAN, GORDON F.

1956. A taxonomic study of cutthroat trout, *Salmo clarki clarki* Richardson, rainbow trout, *Salmo gairdneri* Richardson, and reciprocal hybrids. Master's thesis, University of British Columbia. 71 pp.

Reciprocal hybrid crosses were made of cutthroat and rainbow trout, and the eggs were reared under similar conditions with pure cutthroat and pure rainbow eggs. Viability of hybrid crosses was compared with viability of pure strains, and sex ratios in offspring were studied. Relative growth of several head and body parts was studied in the four lots of fish. Meristic comparison, counts of teeth, and of pyloric caecae, were made. Coloration was studied in all experimental lots of fish. Hybrid crosses were as viable as interspecific crosses, and sex ratios did not differ significantly from those expected. Relative growth studies showed cutthroats had larger heads, larger head parts, and deeper peduncles than rainbows. Hybrids were usually intermediate. Rainbow trout had higher scale, ray, and vertebral counts than cutthroats. Contrary to most authorities, scale counts were higher on rainbows than on cutthroat. Dorsal ray counts for both hybrid lots resembled rainbow parents. Vertebral counts among hybrids tended to resemble female parents. No marked differences were found

in teeth except on the hyoid bone. Pyloric caeca counts were similar in both parental lots. Coloration on rainbows was different from that on cutthroats. Hybrids were intermediate in some aspects of color, and in others they tended to resemble one parent. Eight samples of wild fish were examined, and several features which were distinctive in the hatchery fish were different for the two species in the wild.

HATTON, S. Ross.

1932. The fish fauna of Utah Lake. Master's thesis, Brigham Young University, Provo, Utah. 64 pp.

Synonymy, description, and habits of *Salmo utah* are given. Historical importance of this fish in Utah Lake is discussed. Gradual disappearance of the species from the Great Basin is described.

HAZZARD, A. S.

1932. Preliminary report of a biological survey of the streams and lakes of Grand Teton National Park and Jackson Lake, Wyoming. Unpublished report to the U.S. Bureau of Fisheries. 94 pp.

The cutthroat is treated at some length. Average size and condition factors are given for many waters. Spawning habits and distribution are described for Teton area. Average condition factor for all lakes was 1.345, and for all streams, 1.328.

HAZZARD, A. S., and M. J. MADSEN.

1933. Studies of the food of the cutthroat trout. Transactions of the American Fisheries Society, 63 : 198–207.

Food studies of *S. lewisi* from Jackson Lake, Wyo., Glacier Park, Mont., and other lakes and streams in Teton Park, Wyo., were conducted over three seasons. Diet of smallest fingerlings is diversified, midges being most important item. Considerable variation in diet was seen from stream to stream and from lake to lake. Change in diet at 11½ inches was noted in Jackson Lake fish from crustacea toward fish. A variety of fish species was utilized. Large (11¾ to 14½ inches) cutthroat from Strawberry Reservoir, Utah, had only midge larvae and pupae in their stomachs. Stomachs of *Salmo gibbsii* from Middle Fork of Salmon River in Idaho had great numbers of snails, with fish, fish eggs, caddis flies, and stoneflies. Cutthroat diets are similar to those of other trouts.

HENSHALL, JAMES A.

1902. Food and game fishes of the Rocky Mountain region. Transactions of the American Fisheries Society, 31 : 74–88.

Several common names for cutthroat in the Rocky Mountain region are given. Distribution and habits are discussed.

1906. A list of the fishes of Montana. Bulletin of the University of Montana, No. 34, 13 pp.

Red-throat trout is discussed with reference to distribution, color patterns, and habits.

HILDEBRAND, SAMUEL F., and IRVING L. TOWERS.

1927. Food of trout in Fish Lake, Utah. Ecology, 8(4) : 389–399.

Contents of 181 stomachs of brook, lake, rainbow, and cutthroat trout were studied with reference to physical conditions and plant and animal life of Fish Lake, Utah. *Daphnia*, amphipods, insects, and *Nostoc* colonies were chief organisms found. Lesser numbers of fish eggs, *Pisidium*, snails, and certain higher plants were found.

HOCHACHKA, P. W.

1961. Liver glycogen reserves of interacting resident and introduced trout populations. Journal of the Fisheries Research Board of Canada, 18(1) : 125–135.

Three groups of trout, two introduced populations of *Salmo gairdneri* and a resident *Salmo clarki*, were studied in stream sections. Liver glycogen deposits, which were reduced to low levels during transportation to the stream, were restored in 2 to 3 weeks in all groups, with recovery rates being approximately inverse to the population density. Within the hatchery groups, larger fish laid down greater glycogen stores. Wild trout maintained their high glycogen reserves throughout the experiment.

1963. On the need for measuring the buffering capacity of fish blood. Journal of the Fisheries Research Board of Canada, 20(3) : 845–847.

In this study on fish blood buffering capacity, concentrations of hemoglobin in cutthroat and rainbow trout from the wild were compared with those of several groups of hatchery rainbow. Cutthroat averaged 12.0 g. hemoglobin per ml. of blood for an 8–72 gram group, and 11.3 for a 72–154 gram group. Wild rainbow averaged 11.9 g. for an 18–80 gram group. Hatchery-reared fish generally averaged lower values than those for wild fish.

HOCHACHKA, P. W., and A. C. SINCLAIR.

1962. Glycogen stores in trout tissues before and after stream planting. Journal of the Fisheries Research Board of Canada, 19 (1) : 127–136.

Changes in the glycogen reserves of epaxial and heart muscle of rainbow trout were followed after stream planting. Muscle glycogen

recovered quickly in large fish, more slowly in smaller ones, and was related to earlier reported changes in liver glycogen and blood lactic acid. Heart glycogen increased initially, but fell again shortly after feeding became stabilized. Muscle glycogen reserves of wild cutthroat trout were lower in the presence of hatchery fish than in their absence. A depletion of some metabolite, such as glycogen, in conjunction with an increased body demand due to raised basal metabolism was suggested as a factor in delayed mortality.

HOLMES, W. N., and GAEL H. STOTT.

1960a. Studies of the respiration rates of excretory tissues in the cutthroat trout (*Salmo clarki clarki*). I. Variations with body weight. Physiological Zoology, 33(1) : 9–14.

Oxygen consumptions of kidney and gill tissues of cutthroat trout (*Salmo clarki clarki*) were examined in relation to body weight. A decline in weight specific oxygen consumption with increase in body weight for both tissues was observed (kidney —0.148, gill —0.139). This decline was not significantly different for the two tissues.

The regression coefficients of Q_{O_2} values for kidney and gill tissue (—0.148 and —0.139) were statistically compared to a theoretical value of —0.27, which would correspond to the 0.73 rule. Such comparison showed a highly significant difference (p 0.005, 0.001), indicating that the decline in metabolism of these tissues with increasing body weight is not according to the 0.73 rule.

1960b. Studies of the respiration rates of excretory tissues in the cutthroat trout (*Salmo clarki clarki*). Physiological Zoology, 33(1) : 15–20.

Cutthroat trout (*Salmo clarki clarki*) were transferred from fresh water to 65-percent standard sea water. The oxygen consumptions of kidney and gill tissues were examined during a 168-hour period after transfer.

A sharp initial rise in Q_{O_2} of kidney tissue was noted during the first 48 hours after transfer, reaching a maximum at 20 hours. The tissue respiration during the rest of the experimental period remained significantly higher than the parallel control level.

The gill-tissue respiration declined rapidly during the first 10 hours after transfer and remained significantly below the control level for the whole experimental period.

The results are discussed in relation to recent observations concerning possible hormonal regulation in euryhaline species of salmonoids.

HUEY, WILLIAM S.

1956. New Mexico beaver management. New Mexico Department of Game and Fish, Bulletin No. 4. 49 pp.

During summer of 1955, studies were conducted to determine beaver-trout relations. Two inventories were made in each of six experimental sections of upper Red River in Taos County. Three of these contained beaver ponds and three did not. Each section had 50 yards of stream. Cutthroat, brook, and rainbow trout and white suckers were in the experimental area. Average trout population in beaver sections was 154 in June and 180 in August, as opposed to 33 in June and 47 in August for nonbeaver sections. Trout from beaver ponds were slightly larger than those from nonbeaver sections. Food production was significantly higher in beaver sections and trout growth appeared to be faster in these sections.

HUEY, WILLIAM S., and WILLIAM H. WOLFRUM.

1956. Beaver-trout relations in New Mexico. Progressive Fish-Culturist, 18(2) : 70–74.

Effect of beaver activity on trout production in Red River, N. Mex., was studied. Cutthroat, rainbow, and brook trout were present; cutthroat and brook amounted to 98–99 percent of the trout.

Production was increased in beaver ponds. Ponds produced more trout than undisturbed stream areas, and growth was faster. Cutthroat were apparently not prevented from spawning because of beaver activity.

IDYLL, CLARENCE.

1942. Food of rainbow, cutthroat, and brown trout in the Cowichan River System, B.C. Journal of the Fisheries Research Board of Canada, 5(5) : 448–458.

Stomach contents of 293 rainbow, 160 cutthroat, and 113 brown trout were examined and analyzed according to species, size groups (5 cm.), and habitat (river or lake). For rainbows of both river and lake (4 to 50 cm. in length), insects, chiefly Trichoptera and Simuliidae, were predominant in all size groups. Fish constituted a small fraction of the food except in winter when salmon eggs were available. River cutthroat subsisted chiefly on insects (Trichoptera) up to 15 cm., on insects and fish (*Gasterosteus*) up to 30 cm., thereafter largely on fish. Lake cutthroat did not eat fish in any number until 41 cm. long. Brown trout ate chiefly insects (Trichoptera) up to 45.5 cm., thereafter turning more definitely to a fish (salmonid) diet. Cutthroat

were more piscivorous than brown trout. Definite selection of food by the trout was indicated.

IRVING, ROBERT B.

1953. Ecology of the cutthroat trout, *Salmo clarkii* Richardson, in Henrys Lake, Idaho. Master's thesis, Utah State Agricultural College. 101 pp.

Cutthroat trout of several stocks live in Henrys Lake with rainbow and brook trouts, whitefish, bullhead, and silverside minnow. Limnological data suggest high productivity. Growth is rapid, and body-scale relation is 21.59 mm.+6.879 S_i+0.03874 S_i^2. Only 2 percent of cutthroat reach 5 years of age; 2 percent of rainbow and cutthroat hybrids reach 7 years of age. Length-weight relation of cutthroat is *Log* $W=-4.6353+2.9529$ *Log* L. Average female cutthroat has 2,703 eggs. Average total length of spawners is 18.5 inches for male and 19 inches for female. Sex ratio in 1951 was 96 males to 100 females.

Potential harvest is estimated at 89.2 pounds per surface acre. In 1951 the lake yielded 5.1 pounds per surface acre. Cutthroat in the creel averaged 2.5 pounds.

1956. Ecology of the cutthroat trout in Henrys Lake, Idaho. Transactions of the American Fisheries Society, 84: 275–296.

Henrys Lake in eastern Idaho is a shallow, fertile lake, with an estimated 606 pounds of bottom and plant-inhabiting fauna in 1951. *Salmo clarki, Cottus bairdi semiscaber,* and *Prosopium williamsoni* are the native fish; *Salmo gairdneri, Salvelinus fontinalis,* and *Richardsonius balteatus hydrophlox* are introduced species. Rainbow-cutthroat hybrids were rare in the catch. Body scale relation in cutthroat was $L=21.59+6.879\ R+0.03874\ R^2$. Male cutthroat in 1951 matured at ages II and III, females at ages III and IV. Severe mortality subsequent to spawning is reported for 1951. Variation in growth is attributed to differences between time spent in streams and in the lake, seasonal variation of environmental conditions, and different ages at maturity. Rates of female to male cutthroat in catch decreased with age and progress of season. Ninety percent by number and 74 percent by volume of food were midges, shrimp, and damsel flies. Pathogenic bacteria infected mature fish in 1950, 1951, and 1952 spawning migrations. Asphyxiation was cause of mortalities at mouths of streams in January 1952. The population is short lived owing to disease, asphyxiation, predation, angling, and spawning mortality.

JEPPSON, PAUL W., and WILLIAM S. PLATTS.

1959. Ecology and control of the Columbia squawfish in northern Idaho lakes. Transactions of the American Fisheries Society, 88(3): 197–202.

Columbia squawfish, *Ptychocheilus oregonensis,* and trout were found to occupy similar niches, resulting in competition for food and space, and predation on each other. Mature squawfish are piscivorous, with food habits similar to Dolly Varden, *Salvelinus malma,* rainbow trout, *Salmo gairdneri,* and brown bullhead, *Ictalurus nebulosus.* Age and growth data are presented; in northern Idaho lakes a 13-year-old female squawfish attains a maximum weight of approximately 9 pounds. Males grow slower, averaging less than one-half the size of the females. Spawning by lake populations occurs in lakes and streams. Lake spawning is in schools during late May and early June over wave-washed rubble on clear, calm days. The number of eggs in mature females varies from 12,000 to 100,000, averaging 40,000. Eggs hatch in 7 to 8 days. In 6 years of squawfish control in 3,800-acre Hayden Lake by dynamiting and gill netting spawning schools, mature squawfish were reduced to about one-tenth of their original abundance and an increase in trout was noted.

Food habits of cutthroat trout are presented in tables.

JOHNSON, A. K.

1961. Ichthyophthiriasis in a recirculating closed-water hatchery. Progressive Fish-Culturist, 23(4): 70–82.

Cutthroat and other salmonids were infested with *Ichthyopthiriasis* at the Humboldt State College hatchery in 1958. The pathogen was apparently introduced from other stations. Some parasites were not stopped by filters. Treatment with salt and malachite green brought the infestation under control.

JOHNSON, HARLAN E., and RICHARD F. BRICE.

1952. Observations on columnaris in salmon and trout. Progressive Fish-Culturist, 14(3): 104–109.

Salmonids were reared in water from three levels in Dorena Reservoir in Oregon. No lesions of columnaris disease were seen in any fish in water from the lowest level, where the water was coolest. Columnaris lesions were observed in cutthroat and rainbow trout and king salmon, but not in silver salmon, in water that was near 60° most of the summer. Columnaris caused high mortalities in all salmon and trout reared in water from the high

level, where temperatures were above 65° all summer.

Sulfamerazine in the diet was beneficial to silver salmon and rainbow trout, but not to king salmon or cutthroat trout.

1953. Further observations on columnaris in salmon and trout. Progressive Fish-Culturist, 15(4) : 183–185.

Columnaris in salmon and trout was studied at Cottage Grove, Oregon. Cutthroat trout reared in hatchery troughs suffered mortality from columnaris in water above 65° F; sulfamerazine fed 10 to 13 weeks effectively controlled the disease.

JORDAN, DAVID STARR.

1890. The fishes of the Yellowstone Park. Zoe, 1(2) : 38–40.

Discussion of native fishes of Yellowstone Park. Describes historical geology of area and suggests that *Salmo mykiss* entered Yellowstone Lake and River from Pacific Creek in Snake River drainage.

1891a. Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. Bulletin of the U.S. Fish Commission, 9 : 1–40.

Discussions of distribution, appearance, and biology of *S. m. macdonaldi*, yellow-finned trout; *S. m. stomias*, green-backed trout; *S. m. clarki*, cutthroat trout; *S. m. pleuriticus*, Colorado River trout; *S. m. spilurus*, trout of the Rio Grande; *S. m. virginalis*, trout of Utah Lake; *S. m. bouvieri*, Waha Lake trout; *S. m. henshawi*, Lake Tahoe trout; *S. m. lewisi*, trout of the Upper Missouri.

1891b. A reconnaissance of the streams and lakes of the Yellowstone National Park, Wyoming, in the interest of the United States Fish Commission. Bulletin of the U.S. Fish Commission, 9 : 41–63.

Discusses distribution of each drainage. Much detail is given on distribution of *S. mykiss* and infestation by *Dibothrium* worms. Classified list of waters suitable for *S. mykiss* is presented.

1907. The trout and salmon of the Pacific Coast. State Board Fish Commission of California, Report (1905–1906) : 77–92.

Describes discovery of cutthroat in Oregon by Clark. Movements of trout species in northern hemisphere are described; movement of cutthroat from Alaska southward is traced. Color patterns are given. Tahoe trout and Crescent trout are treated separately.

1920. The trout of the Rio Grande. Copeia, No. 85. pp. 72–73.

Nomenclature of cutthroat is discussed. *Salmo virginalis* is the Rio Grande trout, and *S. utah* is the Bonneville Basin trout.

1928. The distribution of fresh-water fishes. Annual Report of the Smithsonian Institution for 1927. pp. 355–385.

Principles of zoogeography are discussed, including methods of distribution of fishes. Geographic barriers throughout world are described, with their influence on groups of fishes. Dispersal of fresh-water fishes is discussed in general terms and movement of cutthroat over Two-Ocean Pass in Wyoming is treated in detail. Speciation in cutthroat in Great Basin is described.

JORDAN, DAVID STARR, and H. W. HENSHAW.

1879. Report upon the fishes collected during the years, 1875, 1876, and 1877, in California and Nevada. Report of the Chief of Engineers, Part 3, Appendix NN, Appendix K, pp. 1609–1622. Executive Documents, 3d Sess., 45th Cong., 1878–79, vol. 5.

Contains detailed descriptions of *S. tsuppitch* Richardson (black trout), *S. henshawi* Gill & Jordan (silver trout), and *S. pleuriticus* Cope (Rio Grande trout), with notes on distribution and biologies.

JORDAN, DAVID STARR, and BARTON W. EVERMANN.

1902, 1934. American food and game fishes. Pp. 175–179. Country Life Press, Garden City, N.Y.

Keys to species of cutthroat are given. Discussion of distribution, biology, and habits of *S. clarki*, *S. lewisi*, *S. gibbsii*, *S. henshawi*, *S. tahoensis*, *S. utah*, *S. jordani*, *S. bathoecetor*, *S. declivifrons*, *S. virginalis*, *S. pleuriticus*, *S. bouvieri*, *S. stomias*, and *S. macdonaldi* is presented.

JUDAY, CHAUNCEY.

1907a. Notes on Lake Tahoe, its trout and trout-fishing. Bulletin of the U.S. Bureau of Fisheries, 26 : 133–146.

Description of Lake Tahoe, its vegetation, and its plankton is given. Account of *Salmo henshawi* (Lake Tahoe trout, Truckee trout, pogy, and snipe) and *Salmo tahoensis* (silver trout) is presented. Gives distribution, breeding habits, hatchery operation, food habits, angling methods, shipments of trout from the lake, and their commercial value ($6,819 in 1906).

1907b. A study of Twin Lakes, Colorado, with especial consideration of the food of the trouts. Bulletin of the U.S. Bureau of Fisheries, 26 : 147–178.

Describes physical characteristics of the lakes, aquatic vegetation, plankton, and fishes, including *Salmo macdonaldi* (yellow-fin trout) and *Salmo stomias* (green-back trout). Importance of study of fish food is discussed, and details of analyses of fish stomachs are given. *S. stomias* stomachs contained fish remains, insects, crustaceans, and vegetable fragments. Importance of plankton crustacea as fish food is discussed at length.

KEMMERER, GEORGE, J. R. BOVARD, and W. R. BOORMAN.

1924. Northwestern lakes of the United States; biological and chemical studies with reference to possibilities in production of fish. Bulletin of the U.S. Bureau of Fisheries, 49: 51–140.

Physical and biological surveys were made in many northwestern lakes for comparisons with each other and with Wisconsin lakes, and to determine suitability for trout. Cutthroat trout found in Bear Lake, Henrys Lake, Coeur d'Alene Lake, Hayden Lake, Payette Lake, Pend Orielle Lake, Priest Lake, and Spirit Lake, (all in Idaho). Food habits are discussed.

KENDALL, W. C.

1915. The fishes of the Yellowstone National Park. Report of the U.S. Commissioner of Fisheries for 1914, App. 8. pp. 1–28.

Fishing for cutthroat and other species is described for major waters of Yellowstone Park. Tapeworm parasite of cutthroat of Yellowstone is discussed. Detailed distribution of cutthroat is given for Yellowstone Park. Distribution from hatchery is listed.

1920. What are rainbow trout and steelhead trout? Transactions of the American Fisheries Society, 50: 187–199.

The difficulty in classifying *Salmo mykiss* is discussed. Connections between Asian and North American cutthroat are described. The identities of resident rainbow and steelhead are discussed.

LAAKSO, MARTIN.

1955. Variability in scales of cutthroat trout in mountain lakes. Proceedings of the Utah Academy of Science, Arts, and Letters, 32: 81–87.

Some cutthroat trout in mountain lakes fail to establish a year mark during first year of life and have scales designated as "retarded." Fry which are more advanced in their first fall have year marks corresponding to each year of life and are called "normal." Frequency of normal scales was found to be closely correlated (r.=.79) with growth index (quotient of mean length divided by mean age for each sample) in total of 12 areas.

1956. Body-scale regressions in juvenile cutthroat from Yellowstone Lake. Proceedings of the Utah Academy of Science, Arts, and Letters, 33: 107–111.

The body-scale regressions of juvenile cutthroat trout from different areas in Yellowstone Lake showed significant differences in slope. Curves plotted for fingerlings captured near the outlet of Yellowstone Lake exhibited steeper slopes, showing that scale growth was relatively faster than in fish collected along the lakeshore and in two small tributaries.

LAAKSO, MARTIN, and OLIVER B. COPE.

1956. Age determination in the Yellowstone cutthroat trout by the scale method. Journal of Wildlife Management, 20(2): 138–153.

Fishery studies on cutthroat trout in Yellowstone Lake have required investigation into technique of age determination. Scales exhibit growth characteristics different from those of same species in other waters at lower altitudes. Present studies have centered around identification of scales on which first annulus failed to form.

Cutthroat trout in Yellowstone Lake ascend spawning streams from May to late July. Fry emerge from late June to early September. Scale formation is initiated when fish are 41 to 44 millimeters in length. Late-hatched fry may not attain this length before interruption of growth in October, and thus may overwinter without scales or with only a few small scales. As a result, three developmental types of fry occur in the population: (1) fry overwintering in a fully scaled state; (2) fry passing the winter partially scaled; and (3) fry overwintering without scales.

Annulus development after first growing season occurred on scales of fingerlings whose scale growth had reached 4-circulus stage. Late-hatched fry with rudimentary scales failed to establish a year mark during their first fall and winter period. These fish with "retarded" scales exhibit annulus formation following their second growing season. Term "retarded scale" is proposed to designate a scale that does not exhibit an annulus after first growing season, and "normal" is applied to a scale that did establish a year mark after one season's growth. Structural criteria have been established for identification of the two types of scale development. Bases for differentiating the types are (1) numbers of circuli before first annulus, (2) size of focus, or first

circulus, and (3) shape and density of first one or two circuli.

Annulus formation begins before May 1 and is usually complete by middle of June. Spawners appear to initiate scale growth before nonspawners.

Fingerlings taken late in season and presumed to be in first year of life included 35 percent fully scaled individuals, unscaled comprised 22 percent, partially scaled made up 42.7 percent. Adults sampled from 1951, 1952, and 1953 fisheries averaged 40 percent normal.

LAND, S. E.

1913. The black-spotted mountain trout. Transactions of the American Fisheries Society, 42 : 183–198.

Salmo stomias Cope and *Salmo spilurus* Cope are discussed as to distribution and handling.

LEACH, GLEN C.

1923. Artificial propagation of brook trout and rainbow trout, with notes on three other species. Report of the U.S. Comissioner of Fisheries for 1923, App. 6. pp. 1–74.

Describes places where cutthroat trout have been cultured. Spawning season, growth, and egg production are noted. Quotes articles relating to biology of this species. Tapeworm parasite at Yellowstone is discussed.

LINTON, EDWIN.

1891a. On two species of larval dibothria from Yellowstone National Park. Bulletin of the U.S. Fish Commission, 9 : 65–79.

A collection of *Salmo mykiss* and suckers from Yellowstone Park were examined for parasites. Larval cestodes were found in both fishes. Detailed descriptions of anatomies of the tapeworms are given, and figures are presented. *Dibothrium cordiceps* Leidy is the worm found in the cutthroat.

1891b. A contribution to the life history of *Dibothrium cordiceps* Leidy, a parasite infesting the trout of Yellowstone Lake. Bulletin of the U.S. Fish Commission, 9 : 337–358.

Discussions of larval and adult stages of *D. cordiceps* from *Salmo mykiss* in various waters of the Yellowstone and an account of distribution and anatomy and of pelican hosts. Author accounts for abundance of parasitized trout in Yellowstone Lake and migration of parasite into muscular tissue of its host.

1893. On fish entozoa from Yellowstone National Park. Report of the U.S. Commissioner of Fisheries 17 : 545–564.

This paper treats all internal parasites found in a collection of trout, suckers, and chubs from Yellowstone Park. Parasites from *Salmo mykiss* were : tapeworm *Dibothrium cordiceps* Leidy, fluke *Distomum laureatum* Zeder, acanthocephalan *Echinorhynchus globosus* Rud, and nematode *Dacnitis globosa* Dujardin. Details of life history and biology are given for some of these parasites.

LOCKE, S. B.

1929. Whitefish, grayling, trout, and salmon of the intermountain region. Report of the U.S. Commissioner of Fisheries for 1929, App. 5. pp. 173–190.

Identification and description of salmonids in intermountain region are treated. Cutthroat is discussed in the various forms reported for drainages in this region.

LORD, RUSSELL F.

1930. Rearing a brood stock of blackspotted trout. Transactions of the American Fisheries Society, 60 : 164–166.

Sources of blackspotted trout eggs are suffering a decline in abundance, and it seems necessary to rear new brood stocks of this species. Attempts in 1920–22 at Springville, Utah, were unsatisfactory. Experiments at Pittsford, Vt., beginning in 1926, resulted in an egg take of 115,000 eggs in 1930. An 8.6-percent loss was suffered up to the eyed stage. Shipments were made, and fry were feeding nicely at latest report.

MADSEN, DAVID H.

1936. Protection of native fishes in the National Parks. Transactions of the American Fisheries Society, 66 : 395–397.

Planting policies in national parks are discussed, and rainbow-cutthroat hybridization through planting is described. Importance of this trend in Rocky Mountains is stressed. Policy for management of cutthroat and other native species in national parks is presented.

MADSEN, M. J.

1940. Report on age and growth of the cutthroat trout (*Salmo lewisi*) of Yellowstone Lake, Wyoming. Unpublished report of the U.S. Fish and Wildlife Service. 12 pp.

Studies on scales collected from Yellowstone Lake in 1938 and 1939 showed age group III to dominate the fishery, followed by age groups IV, II, and V. Sexes in catch were 54.8 percent males and 45.2 percent females in 1938; in 1939, percentages were 67.4 and 32.6, respectively.

Condition factors were calculated as 1.2271 for 1938 and 1.3027 for 1939. Condition factors for males were higher than for females.

Weight-length relations are presented.

Observations on parasitism by tapeworms were made, showing that in 1938, 31.8 percent of the fish examined were parasitized; in 1939 the percentage was 45.7. Parasitized fish had lower condition factors than did nonparasitized ones.

MASON, JAMES E.

1953. The distribution of four anadromous members of the genus *Salmo* in the northern hemisphere. Progressive Fish-Culturist, 15(2) : 51–56.

Salmo clarki clarki is one of the four anadromous members of the genus *Salmo*. Spawning and migration times are discussed. Cutthroat range in colder waters than the other species. Air and sea surface temperatures are used as indexes of the environments. Maps of distributions and temperature tables are presented.

MCCONNELL, WILLIAM J., WILLIAM J. CLARK, and WILLIAM F. SIGLER.

1957. Bear Lake, its fish and fishing. Utah Department of Fish and Game, Idaho Department of Fish and Game, Wildlife Management Department, Utah State Agricultural College. 76 pp.

The cutthroat is one of three important game fish of Bear Lake. Methods of catching cutthroat are discussed, as well as importance of cutthroat in the fishery. Gill netting showed cutthroat to be most abundant between shore and 75-foot contour throughout year. Life history of cutthroat in Bear Lake is treated, and calculated total lengths to seventh year are given. Creel census showed that 900 to 1,000 cutthroat were caught annually from 1953 to 1956. History of planting cutthroat in Bear Lake is given. Length frequencies of cutthroat taken in creel are figured. It is concluded that present cutthroat population is only slightly exploited, and that if population density were increased, shore fishermen would probably not enjoy greatly increased success.

MERRIMAN, DANIEL.

1935. The effect of temperature on the development of the eggs and larvae of the cutthroat trout (*Salmo clarkii clarkii* Richardson). Journal of Experimental Biology, 12(4) : 297–305.

Eggs of coastal cutthroat were raised from fertilization through hatching at constant temperatures of 11.3°, 8.25°, and 6.35° C. Temperature is not limiting factor in determining length of hatching period. Average size of cutthroat embryos at hatching was smaller at higher temperatures and larger at lower temperatures. Maximum increment of growth occurred about 41st day at 8.25° C. and about 28th day at 11.3° C. Percentage of dry weight of cutthroat embryos showed a steady decrease from about 25 to 14 percent, while that of yolks showed an increase from about 46 to 55 percent. Embryos absorbed water from the yolk, and at a faster rate from the environment, both before and after hatching.

MILLER, RICHARD B.

1952. Survival of hatchery-reared cutthroat trout in an Alberta stream. Transactions of the American Fisheries Society, 81 : 35–42.

Gorge Creek, typical small mountain trout stream in southwestern Alberta, was divided by fish-tight screens into two sections, each about three-quarters of a mile in length. The number of native trout in these was determined by marking and recapture. One section was left as a control. Into the other, 199 3-year-old and 201 2-year-old hatchery-reared cutthroat trout were liberated. Each of the planted trout was weighed and given a numbered Petersen tag before planting. Fish that died were removed daily and weighed. Daily angling was carried on to recapture, weigh, and again release as many as possible. One-third of the 3-year-old fish died, mainly in the first 2 weeks following planting. All lost weight for 40 days, apparently through inability to compete with the native population. By fall (about 100 days after planting) the survivors had regained their planted weights. All, or nearly all, of the 2-year-old fish died, apparently from a combination of shock and starvation. Native trout in experimental section gained weight all summer, and by fall were in as good condition as native trout in control section.

Plans for planting hatchery-reared trout in sections of stream free of native trout and for transplanting native trout into sections containing native trout are described.

1954a. Movements of cutthroat trout after different periods of retention upstream and downstream from their homes. Journal of the Fisheries Research Board of Canada, 11(5) : 550–558.

A homing experiment of cutthroat trout (*Salmo clarki*) was carried out in Gorge Creek, a small trout stream more or less typical of streams of eastern slopes of Rocky Mountains in Alberta. A half-mile portion of the stream was screened off and, into the enclosure thus formed, 105 trout were transferred from above and 104 from below. Each of these was given

a numbered tag and the home locality was recorded. Transfers were made from June 24 to August 13. On August 15 the screens were removed; September 3 to 5, most of the experimental area was poisoned with Fish Tox and the localities of tagged fish recorded. It was found that most of the trout that had been confined for 30 or more days remained in the enclosure area, i.e., they had adjusted to new homes. Exceptions appear to be result of random movements. Trout of upstream origin, confined for less than 30 days, move toward their original home territory. Trout of downstream origin, confined for less than 30 days, show very much less ability to move toward or to find their homes. Hypothesis is that trout are guided by smell in finding home.

A few observations on size of home territory suggest that it is small, perhaps not more than 20 yards of stream. Trout may inhabit same area of stream for at least 3 years.

1954b. Comparative survival of wild and hatchery-reared cutthroat trout in a stream. Transactions of the American Fisheries Society, 83 : 120–130.

Gorge Creek, typical small mountain trout stream on eastern slope of Rocky Mountains, was used in test to measure survival and weight changes in hatchery-reared cutthroat trout (*Salmo clarki*). Resident population of this species exists in the stream. Experimental procedure was to introduce groups of trout into enclosures one-half to three-fourths of a mile long; each trout in a group was given a numbered Petersen tag and weighed before planting. Recapture by angling and reweighing was carried out throughout the season of planting and also in later summers. In this way six lots of pond-reared, one lot of stream-reared, and one lot of transplanted wild cutthroat trout were studied. Pond-reared fish exhibited very low survivals over first (0 to 4.9 percent) and second (0 to 3.1 percent) winter. Survival was largely independent of age. Transplanted wild trout showed survivals of 46.0 to 29.0 percent to second and third summers, respectively. Stream-reared hatchery fish gave an intermediate value (17.2 percent to second summer).

All lots of trout lost weight for some 30 to 40 days when superimposed on a resident population. This loss was more severe and was regained more slowly in pond-reared trout than in transplanted wild trout.

It is held that low survivability of hatchery fish is due to absence of natural selection at early stages in life history.

1955. Trout management research in Alberta. Transactions of the Twentieth North American Wildlife Conference. pp. 242–252.

Experiments were conducted in Gorge Creek in South Saskatchewan River system to learn what happened to hatchery-reared cutthroat trout released in the stream.

With pond-reared cutthroat planted in an area with wild trout, there was an early, heavy mortality, followed by a period in which survivors lost weight. With wild cutthroat transplanted to an area with other wild cutthroat, the wild fish had lower mortalities and less weight loss than the pond fish.

Partially stream-reared cutthroat planted in the stream with wild fish suffered greater mortality than the wild, transplanted fish, but less than the pond-raised fish.

Hatchery-reared cutthroat planted in a stream with no resident population survived well and immediately began to gain weight. All groups showed low survival over first winter.

1957a. Permanence and size of home territory in stream-dwelling cutthroat trout. Journal of the Fisheries Research Board of Canada, 14(5) : 687–691.

Gorge Creek is a small cutthroat trout stream in Alberta on the eastern slopes of the Rocky Mountains. In the summer of 1954, 98 trout were tagged with Petersen tags, weighed, and returned to the pool of capture. In the same summer and in the next two, 58 of these trout were recaptured, some several times, so that, altogether, 83 records were obtained. Twenty-three records are of the first year, 35 from the second, and 25 from the third.

Sixty-seven percent of the recaptures were made in the original pool or less than 200 yards from it. Of the remaining 33 percent, one fish had moved 1.5 miles upstream and remained there. The others had all drifted downstream. The drifters were smaller fish than those that stayed home, and they either lost weight or gained at rates considerably below normal. It is suggested that these fish had been injured by the tags. The general conclusion is that each cutthroat trout of Gorge Creek has a home territory not over 20 yards long and that the whole life is spent in it.

1957b. Have the genetic patterns of fishes been altered by introductions or by selective fishing? Journal of the Fisheries Research Board of Canada, 14(6) : 797–806.

This paper is a review of some of the literature dealing with changes in fresh-water fish populations following exploitation or after introduction of exotic species. The object of the review was to look for changes that could be attributed to alterations in the gene pools of the affected populations. Very little concrete evidence could be found, either because the investigations reviewed were not looking for genetic changes, or because such changes did not occur. Changes in some salmonids may be assigned to introgressive hybridization, particularly where rainbow and cutthroat trout have been put together on the eastern slopes. In many cases, however, exotics have apparently failed to contribute to the gene pool of the resident population, and most hybrids, when they occur, have been of low fertility.

Fishes have a remarkable ability to respond to changes in population density by altered growth rates and times of maturity. These changed characters are not necessarily due to genetic changes and may be explained by assuming that fishes are preadapted to a wide range of conditions. There is a rather speculative suggestion that angling may select less intelligent fish, leading to an upgrading in intelligence of the fish. The general conclusion is that in the light of the existing evidence, great caution must be used in attributing to man-induced changes in fish populations changes in the genetic pattern.

1958. The role of competition in the mortality of hatchery trout. Journal of the Fisheries Research Board of Canada, 15(1): 27–45.

The literature on the survival of hatchery-reared trout after release in streams is reviewed, and the conclusion is reached that survival is poor in lakes and streams where a resident trout population already exists. In streams the deaths of planted trout occur very soon after their release and have been referred to as "delayed mortality." However, a comparison of survivals after planting in occupied and unoccupied streams shows that many of the deaths are not attributable to hatchery background or transportation methods, but largely to some aspect of competition with resident trout. Some investigations which have sought to measure the relative survivability of wild and hatchery trout have not used resident wild trout, and thus a crucial aspect of the competition has been omitted. Investigations at the Alberta Biological Station test stream, Gorge Creek, are described; in these a significant difference in blood lactic acid levels was found between hatchery trout with and without competition from resident trout. A tentative role is assigned competition as follows: introduced trout must compete for niches and for food. In the early stages of this competition they are continuously exercising; they exhaust stores of some metabolite and die either of acidosis or starvation.

Survival of wild cutthroat trout and of stream-reared hatchery trout and blood lactate levels in cutthroat trout are discussed.

MILLER, ROBERT RUSH.

1950. Notes on the cutthroat and rainbow trouts with the description of a new species from the Gila River, N. Mex. Ann Arbor, Mich.: University of Michigan Press. Occasional Papers, Museum of Zoology, No. 529. 42 pp.

Salmo gilae, a new species, is described. It resembles *S. gairdnerii* in some respects and *S. clarkii* in others. Status of trouts of western North America is reviewed. Comparisons between rainbow and cutthroat series are presented and discussed. Origins of *S. clarkii* are discussed.

MILLER, ROBERT R., and J. R. ALCORN.

1946. The introduced fishes of Nevada, with a history of their introduction. Transactions of the American Fisheries Society, 73: 173–193.

History and distribution of *Salmo clarkii henshawi*, *S. c. lewisi*, and *S. c. utah* are described in detail for Nevada. Rainbow-cutthroat hybrids are also discussed, and stocking these species in the same water is discouraged.

MOORE, H. L., O. B. COPE, and R. E. BECKWITH.

1952. Yellowstone Lake trout creel censuses, 1950–1951. U.S. Fish and Wildlife Service, Special Scientific Report—Fisheries No. 81. 41 pp.

Two years of cutthroat trout creel census on Yellowstone Lake gave estimates of catch, effort, numbers of fishermen, and catch per hour for each unit of the fishery. Variances were calculated for catch and effort estimates, and mathematical basis for shoreline census method is described.

Catches of 1950 and 1951 were 199,993 and 207,860 for Yellowstone Lake. Catches per hour ranged from 0.16 to 2.12, depending on the unit of the fishery.

MORRIS, ROBERT W.

1950. An application of electricity to collection of fish. Progressive Fish-Culturist, 12(1): 39–42.

A lightweight, back-pack, DC shocker is described, and its use for collecting cutthroat trout is discussed.

MOTTLEY, C. McC.

1934. The origin and relations of the rainbow trout. Transactions of the American Fisheries Society, 64 : 323–327.

Rainbow and cutthroat forms of trout were evolving from a single salmonine stock in the last interglacial period after having been separated from progenitors of Pacific salmon l y previous glaciation. Salmonine stocks were forced southward at last glaciation and then moved north again as ice melted. Cutthroats came into British Columbia from glacial Lake Bonneville and are found at higher elevations and farther from sea than rainbows.

1937. The number of vertebrae in trout (*Salmo*). Journal of the Biological Board of Canada, 3(2) : 169–176.

The European species of *Salmo* have fewer vertebrae than those from western North America, the mean values of two of each group as reared at the Cowichan hatchery being found to be: *salar* 59.0, *trutta* 58.3, *gairdnerii* 63.5, *clarkii* 62.5. Hatchery-reared *gairdnerii* were usually found to be different from those of the natural environment as well as varying with different experimental conditions, and even differed from their own parents, this seeming on the whole to be related to the temperature during development. A correlation was found between the length of the fish and the number of vertebrae. Caution is suggested in the use of the character for identifying populations of *Salmo*.

MUTTKOWSKI, RICHARD A.

1925. The food of trout in Yellowstone National Park. Roosevelt Wild Life Bulletin, 2(4) : 471–497.

The cutthroat and its environment, water food and surface food, feeding habits, and hints to anglers are discussed.

1929. The ecology of trout streams in Yellowstone National Park. Roosevelt Wild Life Annals, 2(2) : 155–240.

Contains detailed descriptions and classification of Yellowstone trout streams, with lists of flora and fauna. A little about biology of cutthroat itself is given.

NEAVE, FERRIS.

1936. The development of the scales of *Salmo*. Transactions of the Royal Society of Canada, 30 (Third Series, Section V) : 55–72.

The microscopic development of scales in the genus *Salmo* is reviewed. Cutthroat, rainbow, and brown trouts were used during the study, and figures of scale formation in the lateral line area of cutthroat are given. The paper deals with distribution of the first-formed scales, development of scale papillae, differentiation of the papilla, laying down of the scale, the bony layer and the associated cells, and general considerations.

1943. Scale pattern and scale counting methods in relation to certain trout and other salmonids. Transactions of the Royal Society of Canada, 37 (Third Series, Section V) : 79–91.

The development of scale patterns in *Salmo clarki*, *S. gairdneri*, and *S. trutta* is described and discussed. Scale development begins after establishment of lateral line sense organs, and are metamerically distributed. Variations in number of scales are less extreme at the lateral line than at higher levels. Considerable differences between mean scale counts of different intraspecific populations occur. Lateral line counts will usually distinguish individual brown trout from individual cutthroats and steelhead. Cutthroats have a range of 116 to 133, rainbows a range of 114 to 131, and browns a range of variation of 12 scales at the lateral line. At higher levels on the body, cutthroats range from 122 to 177, rainbows from 115 to 159, and browns from 116 to 136.

1949. Game fish populations of the Cowichan River. Fisheries Research Board of Canada, Bulletin No. 84. 32 pp.

Some habits and life history of cutthroat in this British Columbia stream are described. Cutthroat are very widely distributed in this system. They spawn in winter and spring. Immatures may remain up to 2 years in spawning streams. Cutthroat move randomly in streams in winter, aside from movements connected with reproduction. Growth rate is variable. First spawning is usually at 3 or 4 years of age. Spawning more than twice is exceptional.

NEEDHAM, PAUL R., and F. K. CRAMER.

1943. Movement of trout in Convict Creek, California. Journal of Wildlife Management, 7(2) : 142–148.

A two-way fish trap was used in Convict Creek to study movements of brown, cutthroat, brook, and rainbow trout. Numbers of cutthroat trapped were small, and did not conclusively show migration patterns.

NEEDHAM, P. R., and ROBERT J. BEHNKE.

1962. The origin of hatchery rainbow trout. Progressive Fish-Culturist, 24(4) : 156–158.

In this discussion of the rainbow trout of the McCloud River system in California, the presence of cutthroat characteristics in Pit River populations is brought out. The idea is advanced that interior cutthroat entered the Pit River through an early connection with the Goose Lake drainage. Thus, there may be some cutthroat genes in the McCloud River rainbow, which furnished the original stock for hatcheries.

NEEDHAM, PAUL R., and RICHARD GARD.

1959. Rainbow trout in Mexico and California with notes on the cutthroat series. University of California Publications in Zoology, 67(1) : 1–124, plates 1–8, 40 figs., 3 maps.

Variation in rainbow trout was studied in specimens from Mexico and California, the following meristic characters being used: vertebrae, scales, branchiostegal rays, gill rakers, fin rays. Linear characters were also used. Bases for separating various populations of rainbow were found. In a discussion of the cutthroat series, the authors point out the recognition features of the Montana, coast, Yellowstone, Utah, Lahontan, and Independence Lake cutthroats and for rainbow-cutthroat hybrids and steelhead-cutthroat hybrids. The taxonomic status of the cutthroat as possibly being a subspecies of the rainbow is suggested.

OIEN, WAINE E.

1957. A prelogging inventory of four trout streams in Northern Idaho. Master of science thesis, University of Idaho. 92 pp.

In this study of the effects of logging on trout streams an assessment of streams was made before logging. Coastal cutthroat were native to the streams. Lengths and weights of various ages of cutthroat were determined in four streams in 1955 and 1956, prior to logging. Coefficients of condition ranged from 1.48 to 1.76.

OLIVE, JOHN R.

1953. A bibliography of the limnology and fishery biology of Colorado. Colorado Game and Fish Department (mimeographed). 34 pp.

Contains references to many reports and papers on cutthroat in Colorado.

PARISOT, THOMAS J., WILLIAM T. YASUTAKE, and VERNON BRESSLER.

1963. A new geographic and host record for infectious pancreatic necrosis. Transactions of the American Fisheries Society, 92(1) : 63–66.

The occurrence of infectious pancreatic necrosis in rainbow trout (*Salmo gairdneri*), brook trout (*Salvelinus fontinalis*), and cutthroat trout (*Salmo clarki*) has been experimentally authenticated for the first time in the western United States. The cutthroat trout represents a new host. Brook trout fin tissue culture inoculated with bacteria-free filtrate from the diseased fish tissue showed marked degenerative changes after 24 hours. Chinook salmon (*Oncorhynchus tshawytscha*), kokanee (*O. nerka*), and silver salmon (*O. kisutch*) were not susceptible to the virus when inoculated. Histologically extensive pancreatic necrosis was observed in the original and experimental materials, but striated muscle hyalinization was detected only in the original material.

PAUTZKE, CLARENCE F.

1938. Studies on the effect of coal washings on steelhead and cutthroat trout. Transactions of the American Fisheries Society, 67 : 232–233.

Effects of coal washings in Cedar River in Washington were measured on steelhead and cutthroat. Cutthroat, 1 to 2 inches, died in 30 minutes, while the control was unaffected. Steelhead, 6 inches long, died in 1½ hours.

PECHACEK, LOUIS S.

1950. Harvest of wild and stocked fish from the Logan River drainage. Master's thesis, Utah State Agricultural College. 103 pp.

In this study of harvest of cutthroat, brook, brown, and rainbow trouts and mountain whitefish in Logan River in 1949, it was determined that cutthroat comprised 31.5 percent of the catch, rainbows 34 percent (25.5 percent were marked rainbows).

1956. The effects of tags on the rate of growth and condition of several species of cold-water fish in Wyoming. Progressive Fish-Culturist, 18(2) : 120–125.

Cutthroat and other salmonids in Wyoming were tagged with jaw and opercular tags. Loss in growth and in condition factor was exhibited after periods of from 2 months to 2 years.

PLATTS, WILLIAM S.

1957. The cutthroat trout. Utah Fish and Game Magazine, 13(10) : 4, 10.

This account of the cutthroat in Utah describes history and range of Utah cutthroat and Colorado cutthroat. Management of cutthroat in Utah is discussed in relation to environmental changes. Habitat, life history, spawning habits, and development of imma-

ture cutthroat are treated. Future for this fish in Utah is felt to be poor.

1958. Age and growth of the cutthroat trout in Strawberry Reservoir, Utah. Proceedings of the Utah Academy of Science, Arts, and Letters, 35 : 101–103.

The body-scale relation of cutthroat in Strawberry Reservoir is calculated at L= —16.7+2.47 Sc and for tributary stream fish at L= —1.4+1.88 Sc. Calculated lengths show reservoir cutthroat to average 413 mm. at the fourth annulus ; tributary fish average 189 mm. at the fourth annulus. The maximum age found in the reservoir is 10 years. Tributary fish were found up to 4 years of age. Condition factors became smaller up to 3 years of age and increased beyond that age.

1959a. Homing, movements and mortality of wild cutthroat trout (*Salmo clarki* Richardson) spawned artificially. Progressive Fish-Culturist, 21(1) : 36–38.

Cutthroat trout spawners with a strong drive to complete the spawning act were observed to travel the length of the 6-mile reservoir. Many marked spawners traveled 7 miles upstream, where migration was stopped by beaver dams. The high percentage of returns to the home stream gave supporting evidence of a homing instinct of cutthroat trout in an adfluvial environment.

The data indicate that mortality of both naturally and artificially spawned wild cutthroat trout is very high. Once it has completed spawning, a cutthroat trout in this type of environment is of little value to the future replenishment and should be made available to the creel.

1959b. Food habits of the cutthroat trout in Strawberry Reservoir, Utah. Proceedings of the Utah Academy of Science, Arts, and Letters, 36 : 119–121.

In cutthroat stomachs from Strawberry Reservoir and its tributaries, chironomid pupae were the most important food in the reservoir, and *Daphnia* was important to the smaller cutthroat. In the tributaries caddis larvae and snails were the most abundant items. Fish were not prominent in the diet. Cutthroat fry and fingerlings fed on chironomid larvae and mayfly nymphs.

POST, GEORGE

1959. Nitrofuran compounds for furunculosis of trout, with special emphasis on Furoxone. Progressive Fish-Culturist, 21(1) : 30–33.

Six nitrofurans were tested against *Aeromonas salmonicida in vitro*, with Furoxone giving the greatest inhibition. Furoxone was then tested against *Aeromonas salmonicida* in brook and cutthroat trout by addition to the diet, at 100 milligrams per kilo of fish per day. The furunculosis was controlled.

1962. Furazolidone (nf–180) for control of furunculosis in trout. Progressive Fish-Culturist, 24(4) : 182–184.

Cutthroat and rainbow trout were used in experiments on the control of furunculosis. It is recommended that furazolidone at 25 mg. per kilogram of fish be used for at least 20 days for control. Roccal can also be used to disinfect cement ponds and raceways.

PROGRESSIVE FISH-CULTURIST.

1952. Marking cutthroat trout with Trypan Blue. Vol. 14 (No. 1), p. 9.

Trypan Blue gave prominent marks in fins and other parts of cutthroat trout at the Alsea Trout Hatchery in Oregon, but the dye failed to stay in the tissues for 3 weeks.

PURKETT, CHARLES A., Jr.

1951. Growth rate of trout in relation to elevation and temperature. Transactions of the American Fisheries Society, 80 : 251–259.

A study of 758 trout from West Gallatin River indicated that growth was greater at lower elevations where water was warmer. Rainbow trout from upper and lower sections of West Gallatin River showed following differences in length at end of each year : 0.3 inch first year, 1.3 inches second year, 2.1 inches third year, 2.5 inches fourth year, and 4.0 inches fifth year. Growth rates of cutthroat and hybrid trout showed similar trend. Average summer difference in water temperature (early morning), between upper and lower stations of West Gallatin River, was 9.6° F. Condition factors did not show significant variations between sections.

Total of 184 trout from Bridger-Spring Creek did not show significant differences in growth rate. Water temperatures in stream did not vary greatly.

QADRI, S. U.

1959. Some morphological differences between the subspecies of cutthroat trout. *Salmo clarkii clarkii* and *Salmo clarkii lewisi*, in British Columbia. Journal of the Fisheries Research Board of Canada, 16(6) : 903–922.

Coastal cutthroat trout, *Salmo c. clarkii* Richardson, occupy most lakes and streams of coastal British Columbia, including the adjacent islands. Yellowstone cutthroat, *Salmo c. lewisi* (Girard), occupy southeastern British Columbia ; their range is separated from

that of the coastal subspecies by a zone lacking cutthroat trout. A map showing all natural distribution records in the Province is presented. From 60 to 146 specimens were examined for distinguishing characters. Spots below the lateral line are more numerous towards the anterior end in *Salmo c. clarkii*, but more numerous toward the posterior end in *Salmo c. lewisi*. A plot of spot number in selected areas of the body provides almost complete separation of individuals of the two subspecies. Significant differences also occur in certain scale counts and in body and peduncle depth, although these characters overlap considerably between the subspecies. No difference was found in vertebral count.

RASMUSSEN, DELBERT H.

1956. A creel census and fisherman expenditure study on Snake River, Wyoming. Wyoming Game and Fish Commission, Fisheries Technical Report No. 4. 26 pp.

A 40-mile section of Snake River was censused in 1955. Snake River cutthroat comprised 92 percent of catch and averaged 11 inches in length. Length frequencies and length-weight relations are given. Catch per hour for bank fishermen was 0.74, for boat fishermen 0.64.

1960. Preventing a winterkill by use of a compressed-air system. Progressive Fish-Culturist, 22(4) : 185–187.

Cutthroat trout (*S. c. lewisi*) in Soda Lake in the Snake River drainage in northwestern Wyoming sustained a winterkill in 1957–58. Since the population was needed for brood stock and angling purposes, compressed air was used to remove ice cover from the lake. Pumping of air began in November 1958 and lasted 162 days. Eggtaking in May 1959 was successful.

RASMUSSEN, D. I.

1941. Beaver-trout relationship in the Rocky Mountain region. Transactions of the Fifth North American Wildlife Conference. pp. 256–263.

Area in Wasatch National Forest containing 620 miles of stream inhabited by cutthroat, almost 200 miles of which was stocked with beavers, was studied to learn effects beavers had on cutthroat. Physical and chemical measurements and bottom fauna counts suggested that beaver did not produce adverse effects on trout. Beaver dams obstructed trout movement to some extent.

RAYNER, H. J.

1947. Trout fishery in Oregon. Progressive Fish-Culturist, 9(3) : 130–132.

In this description of Oregon's trout fishery, cutthroat play an important role. Anadromous and resident cutthroat west of the Cascades are discussed and Yellowstone cutthroat introductions are described.

REED, ROGER J.

1963. Results of preliminary watershed surveys conducted in 1961 and 1962 for studies on effects of forest insecticide spray on salmon streams in southeastern Alaska. Bureau of Commercial Fisheries, Manuscript Report 63–1. 12 pp.

In this study of DDT in streams prior to spraying for forest insect control, data were collected on stomach contents and on DDT residues of salmonids. Cutthroat stomach contents are reported. DDT and DDE were found in cutthroat from all four streams sampled.

RICH, WILLIS H.

1924. Destruction of trout by pelicans in Yellowstone National Park. Report of the U.S. Commissioner of Fisheries for 1923, App. 7. pp. 1–27.

In 1922, U.S. Bureau of Fisheries began investigation of pelicans in Yellowstone National Park, with Dr. H. B. Ward doing the work. He found that breeding period of white pelican in the park is synchronized with that of cutthroat trout. The pelican colony was 500–600 adults, and produced 200 young. Each pelican ate about 350 fish in the season. Control of pelicans by destruction of eggs was recommended.

RICKER, W. E.

1941. The consumption of young sockeye salmon by predaceous fish. Journal of the Fisheries Research Board of Canada, 5(3) : 293–313.

Among the fish and insects which constitute the principal food of the larger predaceous fish of Cultus Lake, British Columbia, young sockeye salmon (*Oncorhynchus nerka*) are of outstanding importance. In general, the consumption of sockeye is proportional to their abundance, though it may be in some cases modified in the direction of less than proportional predation upon the smaller populations. Consumption of alternative foods increases greatly in years when sockeye are scarce.

Cutthroat trout prey on young sockeye throughout the year, from the time they rise from their nests until they leave the lake a year later. Consumption of sockeye is greatest in May and early June, just after emergence.

Cutthroat were the most important predator in Cultus Lake in 1940.

ROBERTSON, O. H.

1947. An ecological study of two high mountain trout lakes in the Wind River Range, Wyoming. Ecology, 28(2) : 87–112.

This study sought to explain difference in sizes of cutthroat trout from two adjacent, similar lakes. Life spans were about equal, but growth was faster in one lake. This lake had a better food supply, and its trout had food volumes in their stomachs thrice those of the smaller trout. No differences between the lakes were found in plankton counts, temperature, pH, O_2, dissolved Ca, or HCO_3. The richer lake had higher concentrations of phosphates, iodine, and organic matter.

ROUNSEFELL, GEORGE A.

1957. Fecundity of North American Salmonidae. U.S. Fish and Wildlife Service Fishery Bulletin, No. 122, Vol. 57, pp. 451–468.

Measurements of egg diameters of cutthroat trout are compared with those of other salmonids. Measurements on number of eggs per female are given in relation to size of female, as well as other measures of egg size.

1962. Relationships among North American Salmonidae. Fish and Wildlife Service Fishery Bulletin 209, Vol. 62, pp. 235–270.

The relationships among species and genera of North American Salmonidae are assessed from published data on hybridization, coloration, and other attributes. The genus *Salmo* shows the greatest intrageneric variation. Phylogenetically, *Salmo gairdneri* is as close to the species of *Oncorhynchus* as to *Salmo salar;* and *Salmo trutta*, at the other extreme, is about midway between *S. salar* and the species of *Salvelinus*. The genus *Salvelinus* is a closely knit group. Of its species, *Salvelinus marstoni* shows the closest affiliation with *Salmo*.

Published data are scanty for several species, and the methods of taking and recording data vary so widely that comparison of data taken by different investigators is hazardous.

For cutthroat trout, data are presented on hybridization, coloration, anadromy, numbers of branchiostegal rays, numbers of pyloric caecae, counts of fin rays, numbers of vertebrae, numbers of gill rakers, and numbers of scale rows. Figures are also given for fecundity and weight of fish, and the distribution of the species is given in relation to temperature.

RUCKER, R. R., and K. HODGEBOOM.

1953. Observations on gas-bubble disease of fish. Progressive Fish-Culturist, 15(1) : 24–26.

Cutthroat and rainbow trout in a Washington hatchery were troubled with gas-bubble disease due to an excess of nitrogen in the water. When aeration lowered the nitrogen content to 110 percent of saturation the fish showed no evidence of gas-bubble disease.

RUCKER, R. R., J. F. CONRAD, and C. W. DICKESON.

1960. Ovarian fluid: Its role role in fertilization. Progressive Fish-Culturist, 22(2) : 77–78.

This study presents evidence that sperm from cutthroat trout and silver salmon were activated by ovarian fluid, that the ovarian fluid prolonged the viability of the sperm, and that eggs can be fertilized in ovarian fluid without the addition of water.

RUCKER, R. R., W. T. YASUTAKE, and H. WOLF.

1961. Trout hepatoma—a preliminary report. Progressive Fish-Culturist, 34(1) : 3–7.

Hepatoma in trout is discussed and characterized as it occurs in rainbow and cutthroat.

SCHNEIDER, PHILLIP W., and FRANCIS P. GRIFFITHS.

1943. Production of trout in a small artificial pond in western Oregon. Journal of Wildlife Management, 7(2) : 148–154.

Stocking of trout in Cronemiller Pond resulted in no reliable survival data on rainbows and brown trout. Later stocking of cutthroat fingerlings with wild rainbow fry resulted in survival of 71.3 percent after 14.5 months for the cutthroat. Production was 46.5 pounds per surface acre.

SCHOENTHAL, NORMAN D.

1963. Some effects of DDT on cold-water fish and fish-food organisms. Federal Aid to Fish Restoration Project Completion Report, Project Nos. F–21–R–4, Helena, Mont. (mimeographed). 47 pp.

Bioassays were conducted on six species of cold water fish, including wild cutthroat trout, to determine mortality rates under different concentrations of DDT and varying physical, chemical, and biological conditions. A total of 6,000 fish was tested. The mortality of rainbow trout varied little at DDT concentrations between 0.5 and 10 p.p.m. Mortality increased as the size of the fish decreased. Hatchery rainbow trout had a higher mortality than wild rainbow trout. Mortality increased as the temperature increased but decreased when the turbidity and alkalinity increased. Mortality was increased by feeding trout aquatic insects treated with DDT. A comparison of six species of fish tested in 1 p.p.m. DDT showed the longnose sucker had a mortality of 94 percent while the salmonids had less than 10 percent. Delayed mortality

occurred in all species of fish treated in DDT throughout a 6-month observation period.

Observations were made on fish and fish-food organisms in a test stream 8 months before, during, and 19 months after treatment with DDT which was applied at one point in the stream at 0.4 p.p.m. Immature aquatic insect populations were reduced 99 percent following application and required 18 months to regain pretreatment numbers. Immature aquatic insect populations below 0.75 mile downstream from the point of application regained 15 percent of the pretreatment numbers 11 months after application. The diet of trout in this downstream area changed from immature aquatic insects to adult insects and aquatic vegetation. Trout populations in the first mile of treated water showed no significant change 1 year following treatment but below this point showed a 73-percent reduction.

SCHULTZ, LEONARD P.

1934. Species of salmon and trout in the northwestern United States. Proceedings of the Fifth Pacific Science Congress of the Pacific Science Association (Can.), 5: 3777–3782.

Contains brief discussion and keys, in which cutthroat is included.

1936. Keys to the fishes of Washington, Oregon, and closely adjoining regions. University of Washington Publications in Biology, 2(4) : 103–228.

Contains keys to cutthroats.

1941. Fishes of Glacier National Park, Mont. U.S. Department of the Interior, Fish and Wildlife Service, Conservation Bulletin 22. 42 pp.

Has an account of distribution, keys to species, abundance, appearance, and habits of fishes of Glacier Park. Two forms of cutthroat, *S. c. lewisi* and *S. c. clarkii*, are treated. Detailed distributional tables for park waters and fishes are presented.

SIMON, JAMES R.

1935. A new species of nematode, *Bulbodacnitis scotti*, from the trout, *Salmo lewisi* (Girard). University of Wyoming Publications, 2(2) : 11–15.

Contains description of new nematode from intestine and other viscera of *Salmo lewisi* in Yellowstone Lake.

1939, 1953, 1962. Yellowstone fishes. Yellowstone Library and Museum Association. 49 pp.

Fish-cultural practices for cutthroat in Yellowstone, parasites of cutthroat in the park, and natural predators on cutthroat are discussed. Description of Yellowstone cutthroat is given with notes on habits and distribution in Yellowstone.

1946. Wyoming fishes. Wyoming Game and Fish Department, Bulletin No. 4. 129 pp.

Keys to identification of cutthroat are given, and sections on *S. clarki lewisi*, cutthroat-rainbow hybrids, *S. c. pleuriticus*, and *S. c. stomias* cover distribution in Wyoming, biology, and fishing. Illustrations of cutthroat and hybrids are included.

SLATER, JOHN V.

1961. Comparative accumulation of radioactive zinc in young rainbow, cutthroat, and brook trout. Copeia, No. 2. pp. 158–161.

An analysis of the comparative accumulation of radioactive zinc in young rainbow, cutthroat, and brook trout reveals that the greatest rate of accumulation of this isotope is in the brook trout, the least in the rainbows. A study on the localization of this element showed that in the rainbow trout and the cutthroat, the gill filaments accumulated the greatest amount of isotope while in both instances the least amount was discovered in the ventral body wall. Ion uptake in the cutthroat gill was greater than in that of the rainbow with this latter species being found to accumulate only about one-half that discovered in the cutthroat gill.

The rate of accumulation of zinc in the rainbow trout was only 75 percent that found in the brooks. The final total concentration of the ion in 48 hours was found to be greatest in the brook trout, with about 95 percent of this concentration being found in the cutthroats and about 70 percent of the highest concentration seen in the rainbows.

SMITH, HUGH M., and WILLIAM C. KENDALL.

1921. Fishes of the Yellowstone National Park. Report of the U.S. Commissioner of Fisheries for 1921, App. 3. pp. 1–30.

Cutthroat is listed as one of indigenous species in Yellowstone. Hatchery operations with cutthroat are described. Section on cutthroat gives detailed distribution within Yellowstone Park, discusses fishing, and gives something on tapeworm parasite of fish in these waters.

SMITH, OSGOOD R.

1941. The spawning habits of cutthroat and eastern brook trouts. Journal of Wildlife Management, 5(4) : 461–471.

Spawning cutthroat were studied in Convict Creek, Calif., and observations made on distribution of fish and spawning periods, numbers of eggs retained by females, spawning

activities, night spawning, egg predation, guarding completed redd, and damage to eggs by overlapping of redds. Contains excellent photographs of spawning.

1947. Returns from natural spawning of cutthroat trout and eastern brook trout. Transactions of the American Fisheries Society, 74 : 281–296.

Experiments were conducted over three seasons to determine number of fingerlings or fry produced by natural spawning of cutthroat (*Salmo clarkii henshawi*) and eastern brook trout (*Salvelinus fontinalis*). Returns were secured by inducing wild trout to spawn in controlled and screened section of stream. Resulting fingerlings were collected by diverting water and pumping pools dry.

Cutthroat spawned in May and fingerlings were recovered in September each year.

During first summer, horizontal screens, acting as fish traps, were used below cutthroat spawning areas so that some fry were trapped soon after emerging from gravel. Other fry remained in the section and were recovered in September. Minimum survival was about 17 percent of estimated number of eggs laid. Data were obtained on fry migration and growth of fry spawned at same time.

Vertical screens were used in all other experiments so that all survivors were collected in September. Survivals of cutthroat ranged from nothing to about 6 percent of estimated number of eggs in four trials, each trial section containing one to three female spawning trout.

SMITH, S. B.

1955. The relation between scale diameter and body length of Kamloops trout, *Salmo gairdneri kamloops*. Journal of the Fisheries Research Board of Canada, 12(5) : 742–753.

The scale-body relation for Kamloops trout is very close to direct proportion for fish larger than 4.5 cm. fork length. Observations on steelhead trout, *Salmo gairdneri gairdneri*, and on coastal cutthroat trout, *Salmo clarki clarki*, suggest that an isometric scale-body relation may exist among those species also. McMynn and Vernon have shown relation in cutthroat to be linear with a log-log regression-line slope of 1.019, compared with 1.024 for Kamloops and 1.010 for steelhead.

SNYDER, GEORGE R., and HOWARD A. TANNER.

1960. Cutthroat trout reproduction in the inlets to Trappers Lake. Colorado Department of Game and Fish, Technical Bulletin No. 7. pp. 1–86.

An evaluation of the reproductive potential of the cutthroat trout which spawn in the inlet streams to Trappers Lake in Colorado was made from June to September, 1958 and 1959. Information was recorded for times of spawning runs, numbers of spawners, sizes of spawners, age distribution of spawners, sex ratios in spawning runs, numbers of spawners returning to spawn the second year, fecundity, physical condition of spawning areas, times of fry migration, numbers of fry migrating, and survival of hatching eggs.

SNYDER, J. O.

1917. Fishes of the Lahontan system of Nevada and Northeastern California. Bulletin of the U.S. Bureau of Fisheries, 35 : 31–86.

In this account of all fishes in this basin, *Salmo henshawi* is given a long treatment. Details of color patterns from different drainages are given, as well as counts of spots on body areas. Very detailed measurements of specimens from different waters, of both sexes, and of different size groups are shown in tables. Migrations of cutthroat are discussed. The famous large cutthroat of Pyramid Lake are described. Methods of fishing and types of gear used are discussed.

1940. The trouts of California. California Fish and Game, 26(2) : 96–134.

Descriptions of morphology, distributions, and biologies and life histories of *Salmo clarki*, *Salmo henshawi*, *Salmo seleniris*, and *Salmo pleuriticus* are given in this treatment of trouts in California.

SUCKLEY, GEORGE.

1874. On the North American species of salmon and trout. Report of the U.S. Commissioner of Fisheries for 1872–73, pp. 91–160.

This catalog of North American Salmonidae classifies the genus *Salmo*, with anadromous salmons and trouts separated from nonanadromous species. Each species is individually treated with discussion of nomenclature, morphological characteristics, colors, diagnostic features, habitat, life-history notes, and taxonomic relations. Cutthroats treated are *Salmo tsuppitch* Richardson, *Salmo clarkii* Richardson, *Salmo virginalis* Girard, *Salmo lewisi* Girard, *Salmo stellatus* Girard, *Salmo gibbsii* Suckley, and *Salmo brevicauda* Suckley.

SUMNER, FRANCIS H.

1940. The decline of the Pyramid Lake fishery. Transactions of the American Fisheries Society, 69 : 216–224.

History of Pyramid Lake (Nevada) cutthroat trout (*Salmo henshawi* Gill and Jordan)

fishery, conducted by reservation Indians, shows a rapid decline in catch within last few years. While the Indian is blamed for overfishing, the white man's demand for trout, the dams and diversions that he built along the Truckee River where the trout have spawned, the pollutants that he has dumped into the river, the spawn that he has taken, the competing species of fish that he has introduced, and principally the large amounts of water that he has diverted to another watershed, have led to a condition which has prevented the trout from reproducing its kind. Revival of the fishery is made doubtful by an agreement concerning use of Truckee River's flow, expense of hatching and rearing a stock of Pyramid Lake trout (not to mention questionable availability of its eggs), and inadequate regulation of the fishery. The Pyramid Lake cutthroat trout fishery appears to be doomed.

1948. The coast cutthroat trout. Oregon State Game Commission Bulletin, 3(12) : 1, 6–8.

Study on a coastal stream, Sand Creek, was begun in 1946, with upstream-downstream traps. "Blue-back" trout (salmon-trout, harvest trout) appear in coastal streams in October in many color phases. Upstream mortality was around two-thirds. Sand Creek cutthroat spend 1 to 5 years in the stream before migrating to the ocean, most doing so at 3 years of age. In the 1946 spawning run, 19.2 percent had spawned once before, 7.0 percent twice, and 1.5 percent three times. Some may spawn without ever having gone to the ocean.

1953. Migrations of salmonids in Sand Creek, Oregon. Transactions of the American Fisheries Society, 82 : 139–150.

Upstream and downstream fish traps were maintained on Sand Creek, a small Oregon trout stream, during four upstream and three downstream fish runs (1946–49), and a smaller trap was operated on a tributary during part of 1947. Two trouts, *Salmo clarki clarki* and *Salmo gairdneri gairdneri*, and two salmons, *Oncorhynchus kisutch* and *Oncorhynchus keta*, made spawning runs in fall and winter ; downstream migrations of fry and fingerlings occurred in the spring.

Water temperatures and information on occurrence and magnitude of freshlets were taken. Records on fish trapped included numbers of salmonids, lengths, weights, sex ratios, loss in weight after spawning, and survival rates.

Cutthroat upstream migrants ranged from 4.0 to 10.7 inches in fork length for one size group and from 11.0 to 18.6 inches in another size group. Sex ratios of sea-run cutthroat showed predominance of females (1.00 male to 1.69 female). Weights of migrating cutthroat ranged from 0.50 to 2.94 pounds. Fork lengths of downstream migrants were from 2.7 to 10.9 inches.

Survival of cutthroat spawners averaged 32 percent. Weight loss of spawners was about one-third.

1962. Migration and growth of the coastal cutthroat trout in Tillamook County, Oregon. Transactions of the American Fisheries Society, 91(1) : 77–83.

Coastal cutthroat trout (*Salmo clarki clarki* Richardson) were studied at Sand Creek, Tillamook County, Oreg. (1946–49). Upstream runs occurred mainly in fall and early winter months and downstream runs in the spring. Upstream migrant sea-run cutthroat averaged 13.6 inches, while upstream nonsea trout averaged 6.0 inches, fork length. Downstream trout, mainly initial migrants, averaged 5.7 inches long. Of summer-resident trout, 8.7 percent were of legal angling length. Scales of sea-run trout gave ages of 2 to 10 years, with different combinations of stream and sea life. Most sea-run trout spawned after one season in the sea and a third of the run had spawned one to three times. Growth was back calculated from scale reading. Survival figures are given.

TANNER, V. M.

1936. A study of the fishes of Utah. Proceedings of the Utah Academy of Science, Arts, and Letters, 13 : 155–184.

This treatment of fishes of Utah has keys to several forms of cutthroat, and a discussion of findings of some early explorers with regard to distribution and abundance of cutthroat in Utah waters.

TANNER, V. M., and SHELDON P. HAYES.

1933. The genus Salmo in Utah. Proceedings of the Utah Academy of Science, Arts, and Letters, 10 : 163–164.

Two cutthroats, *S. utah* Suckley and *S. pleuriticus* Cope, are in Utah. Yellowstone and Pyramid Lake cutthroats have been introduced and have mixed with native forms. Suckley, Goode, Jordan and Evermann, and Cope are quoted with regard to cutthroats on which they worked.

THOMPSON, R. B.

1959. Tricaine Methanesulfonate (M.S. 222) in transport of cutthroat trout. Progressive Fish-Culturist, 21(2) : 96.

Tricaine methanesulfonate was used to reduce the water-to-fish ratio for planting of

cutthroat trout near Seattle, Wash. The best method was to use 500 ml. of a 1:40,000 concentration of the agent in 1-quart plastic food containers. Thus, 500 cutthroat, 3,000 to the pound, were put into each container, the lid sealed, and the container put into an iced picnic bag. Three hours later, only 19 out of 2,000 fish were considered to be dead.

TRYON, C. A. Jr.

1943. The effect of covering hatchery troughs on the growth of cutthroat trout (*Salmo clarkii*). Transactions of the American Fisheries Society, 72: 145–149.

An experiment was designed and carried out to test effect of covered troughs on growth rate of cutthroat trout at Bozeman, Mont. Analysis of data showed trout in open troughs to have significantly greater growth rate than those in covered troughs. Growth rate in open troughs was greater by 13.8 percent.

TUNISON, A. V., and C. M. MCCAY.

1933. The nutritional requirements of brook trout. Transactions of the American Fisheries Society, 63: 167–177.

In this study on nutrition of trout a group of cutthroat trout became infested with *Octomitis salmonis*. Antiseptics were fed in liver. Control of moving forms was achieved with mercurous chloride, 0.2 percent, Hexamethylenamine, 0.5 percent, and Naphthol (beta), 0.5 percent, and partial control with carbon tetrachloride, 0.2 percent.

TURNER, C. L.

1946. A case of hermaphroditism in the cutthroat trout. Chicago Academy of Sciences Natural History, Miscellanea No. 1, pp. 1–2.

A female cutthroat (*Salmo clarkii*) from Yellowstone Lake was examined by the author. Ovaries were normal. At the anterior end of the right ovary was a flattened oval mass, which was examined histologically. This was a small testis, with mature spermatozoa and nests of spermatogonia.

Hermaphroditism as a normal situation in other fishes is discussed.

UNITED STATES COMMISSION OF FISH AND FISHERIES.

1900. A manual of fish culture. From Report of the U.S. Commissioner of Fisheries for 1897. 340 pp.

This manual deals with all aspects of culture of fishes raised in the United States. A small section is devoted to cutthroats.

VERNON, E. H., and R. G. MCMYNN.

1957. Scale characteristics of yearling coastal cutthroat and steelhead trout. Journal of the Fisheries Research Board of Canada, 14(2): 203–212.

Some scale characteristics of 88 yearling coastal cutthroat trout (*Salmo clarki clarki*) and 96 yearling steelhead (*Salmo gairdneri*) were compared in some detail. Although the number of diagonal scale rows above the lateral line was significantly higher in cutthroat, counts of the two species overlap. Correlation of scale circuli counts with scale diameter was 0.94 for steelhead and 0.90 for cutthroat. At any given scale size, cutthroat scales had 8 percent more circuli than steelhead scales. Measurements of lateral and longitudinal diameters and anterior radii of scales show that the anterior portions of cutthroat scales tend to be longer and narrower than those of steelhead.

Regression analyses of each scale measurement on fork length indicated that, for any given fork length, cutthroat scales are smaller than those of steelhead, the greatest difference being apparent when anterior radii are compared. Growth of scales in a dorsoventral plane approximates isauxesis in relation to fork length, but scale growth in a longitudinal plane tends toward positive heterauxesis which is particularly pronounced in the anterior portions of scales.

Multiple regression analyses of scale diameter, scale row count, and fork length indicated that the smaller size of cutthroat scales is not balanced by proportionate increase in their number. When scale diameter is adjusted for scale number and fork length, cutthroat scales are 15.6 percent smaller than those of steelhead, indicating that young cutthroat are covered by their scales with less overlap.

WALES, J. H.

1957. Trout of California. California Department of Fish and Game, Sacramento. 56 pp.

The coast cutthroat trout, the Piute cutthroat trout, and the Lahontan cutthroat trout are discussed with regard to distinguishing characteristics, distribution in California, and interesting facts. A figure of each subspecies is given.

WARD, H. B.

1923. The pelicans of Yellowstone Lake. Typewritten report to the U.S. Bureau of Fisheries. pp. 1–20.

Relations of the white pelican and the fish of Yellowstone Lake in 1922. Feeding habits of the pelicans were closely observed. Of the fish eaten, 98 percent were cutthroat trout.

It is estimated that 350,000 cutthroat were taken by pelicans in 1922.

WEISEL, GEORGE F.

1957. Fish guide for intermountain Montana. Montana State University Press, Missoula. 88 pp.

This contains a discussion of the differences between *Salmo clarki clarki* and *S. c. lewisi* in Montana. Some notes on biology and spawning habits are included.

WELSH, JAMES P.

1952. A population study of Yellowstone black-spotted trout (*Salmo clarkii lewisi* Girard). Ph. D. dissertation, Leland Stanford Junior University. pp. 1–180.

A study of cutthroat populations in Arnica Creek, tributary of Yellowstone Lake, Yellowstone National Park, was made in 1950 and 1951. Sex ratio in the 1951 runs was 90 males to 102 females. Length-weight regression of Arnica Creek resident trout was calculated at Log Y=3.002 Log X—5.063. Egg counts ranged from 745 to 1,495 per female. Times of spawning runs and their variation within the season are discussed at length.

WHITNEY, ARTHUR N., and JOHN C. SPINDLER.

1959. Effects of kraft paper wastes on a Montana stream. Transactions of the American Fisheries Society, 88(2) : 153.

A paper mill began operating in November 1957 on the Clark Fork River, discharging kraft process wastes into the river. Cutthroat and other fish were found dead for 25 miles downstream the following July, and pathological examination showed death to be by poisoning. Bottom fauna were seriously reduced at a station 2 miles downstream. Rainbows in live cars one-half mile below the effluent outlet all died in 30 hours.

WILDE, EARL.

1961. Cutthroat brood stock. Wyoming Wildlife, 25(5) : 25–27.

The decline of the cutthroat in the Rocky Mountains is discussed, and the development of a brood stock of Snake River cutthroat is described. Details of the culture of eggs and fry leading to the brood stock are given, and the care and use of the progeny are discussed. There is promise that selective breeding will result in earlier dates of maturity and improved brood stock.

WILLOUGHBY, HARVEY.

1951. Age and growth of the cutthroat trout, *Salmo clarkii lewisi*, in Yellowstone Lake. Yellowstone Nature Notes, Yellowstone Library and Museum Association, 25(3) : 29–32.

Scales were read from 523 cutthroat collected from Yellowstone Lake in 1949. Age distribution and growth rate were figured. Year class IV was best represented, followed by III, V, and VI.

WOLF, KEN.

1954. Progress report on blue-sac disease. Progressive Fish-Culturist, 16(2) : 51–59.

In this report on the history, symptoms, and course of blue-sac disease, the appearance of the disease in Yellowstone cutthroat is treated. Photographs of normal and diseased cutthroat are shown.

WOOD, E. M., and W. A. DUNN.

1948. Fact and fiction in spawntaking. Progressive Fish-Culturist, 10(2) : 67–72.

Taking of Yellowstone cutthroat eggs at Yellowstone Lake is described, and the best methods discussed. Water-hardening, male-female ratio, water in the spawning pan, effects of impurities, and general practices are treated in the discussion.

WOODBURY, L. A.

1934. Parasites and diseases of the trout of Yellowstone Lake (*Salmo lewisi*). Master's thesis, University of Utah. pp. 1–60.

Treats body constants of Yellowstone cutthroat, food habits in relation to parasites, neoplasms, muscular abcess, subcutaneous abcess, gill disease, phycomycetosis, protozoan infestation, trematodes, cestodes, nematodes, acanthocephala, and copepoda.

WUSTENBERG, DONALD WILLIAM.

1954. A preliminary survey of the influences of controlled logging on a trout stream in the H. J. Andrews Experimental Forest, Oregon. Master of science thesis, Oregon State College. 51 pp.

In a study of methods and effects of logging, it was found that populations of cutthroat trout were eliminated from three small tributaries as a result of logging operations.

WYATT, BRUCE.

1959. Observations on the movements and reproduction of the Cascade form of cutthroat trout. Master of science thesis, Oregon State College. 60 pp.

Cutthroat in Lookout Creek on the Willamette National Forest were studied in 1956 and 1957. Of the trout in the system, 95 percent were less than 4 years old. No downstream movement of adults was seen. Two up-

stream movements, one from October through January, and the other from March to June, took place. The spring movement was a reproductive migration. Fry moved downstream from June to August. Small tributaries may be insignificant as brood waters for Lookout Creek.

YARROW, H. C.

1874. On the speckled trout of Utah Lake, *Salmo virginalis* Girard. Report of the U.S. Commissioner of Fisheries for 1872–73, App. B, Ch. XII, pp. 363–368.

Life history of red-throated trout, *Salmo virginalis*, in Utah Lake, treating spawning, feeding, and movements. Maximum length was 3 feet, maximum weight 15½ pounds.

INDEX BY SUBJECTS

Age :
Bilton and Shepard, 1955.
Bulkley, 1959, 1961.
DeWitt, 1954a.
Laakso, 1955.
Laakso and Cope, 1956.
Madsen, M., 1940.
Platts, 1958.
Snyder and Tanner, 1960.
Willoughby, 1951.
Alaska :
Bean, 1894b.
Evermann and Goldsborough, 1907.
Jordan, 1907.
Reed, 1963.
Alberta :
Miller, 1952, 1954a, 1954b, 1955, 1957a, 1958.
Anaesthetic :
Cope, 1953a.
Angling :
Cope and Yarrow, 1875.
Dymond, 1932.
Evermann and Goldsborough, 1907.
Juday, 1907a.
Muttkowski, 1925.
Simon, 1946.
Yarrow, 1874.
Aquatic Plants :
Benson, 1961.
Arizona :
Cope and Yarrow, 1875.
Arnica Creek :
Ball and Cope, 1961.
Benson, 1960.
Cope, 1956, 1958b.
Welsh, 1952.
Bear Lake, Idaho and Utah :
Kemmerer, Bovard, and Boorman, 1924.
McConnell, Clark, and Sigler, 1957.
Beaver-trout :
Grasse, 1949.
Huey, 1956.
Huey and Wolfrum, 1956.
Rasmussen, D. I., 1941.
Bibliography :
Bean, 1894b.
Cope, 1958a.
Olive, 1953.
Blood :
Black and Barrett, 1957.
Blue-sac disease :
Wolf, 1954.
Body-scale relation :
Bjornn, 1957.
Fleener, 1952.
Irving, 1953, 1956.
Laakso, 1956.
Platts, 1958.
Smith, S. B., 1955.
Bottom fauna :
Benson, 1961.
British Columbia :
Bangham and Adams, 1954.
Black and Barrett, 1957.
Dymond, 1928, 1931, 1932.
Haig-Brown, 1939.
Idyll, 1942.
Mottley, 1934.
Neave, 1949.
Qadri, 1959.
Ricker, 1941.
Vernon and McMynn, 1957.
Business, trout :
DeWitt, 1954b.
California :
Benson and Behnke, 1961.
Calhoun, 1944a, 1944b.
Cope and Yarrow, 1875.
DeWitt, 1954a.
Gard, 1953.
Jordan and Henshaw, 1879.
Juday, 1907a.
Needham and Cramer, 1943.
Smith, 1941, 1947.
Snyder, 1917, 1940.
Wales, 1957.
Canada :
Barrett, 1951.
Hochachka, 1961.
Catch statistics :
Bilton and Shepard, 1955.
Bjornn, 1961.
Bulkley, 1961.
Cope, 1957a.
Moore, Cope, and Beckwith, 1952.

Cedar River, Wash.:
Pautzke, 1938.
Classification:
Miller, R., 1950.
Schultz, 1934.
Simon, 1946.
Snyder, 1917, 1940.
Suckley, 1874.
Coeur d'Alene Lake, Idaho:
Kemmerer, Bovard, and Boorman, 1924.
Colorado:
Bulkley, 1959.
Drummond and Tanner, 1960.
Ellis, 1914.
Greene, 1937.
Jordan, 1891a.
Juday, 1907b.
Olive, 1953.
Snyder and Tanner, 1960.
Coloration:
Bulkley, 1963.
Dymond, 1932.
Ellis, 1914.
Evermann, 1891.
Evermann and Goldsborough, 1907.
Hartman, 1956.
Henshall, 1906.
Jordan, 1907.
Rounsefell, 1962.
Snyder, 1917.
Suckley, 1874.
Columbia River:
Gilbert and Evermann, 1894.
Columnaris:
Johnson and Brice, 1952, 1953.
Competition:
Biesinger, 1961.
Bjornn, 1958.
Miller, 1958.
Condition factor:
Bachman, 1958.
Fleener, 1952.
Griffiths and Yoeman, 1940.
Hazzard, 1932.
Madsen, 1940.
Oien, 1957.
Pechacek, 1956.
Conversion, food:
Bonham and Williams, 1948.
Convict Creek, Calif.:
Needham and Cramer, 1943.
Smith, 1941, 1947.
Copepods:
Cope, 1958b.
Cowichan River, British Columbia:
Idyll, 1942.
Neave, 1949.
Creel census:
Ball and Cope, 1961.
Bilton, 1952.
Bilton and Shepard, 1955.
Bulkley, 1959.
Cope, 1957a.
Gee, 1941.
Moore, Cope, and Beckwith, 1952.
Rasmussen, D. H., 1956.
Culture:
Davis, 1947, 1953.
Juday, 1907a.
Leach, 1923, 1939.
Lord, 1930.
Simon, 1939, 1953.
Smith and Kendall, 1921.
Tryon, 1943.
United States Fish Comm., 1900.
Currents:
Benson, 1961.
Cutthroat, coastal:
Bachman, 1958.
Black and Barrett, 1957.
Cramer, 1940.
DeWitt, 1954a.
Donaldson, Hansler, and Buckridge, 1957.
Dymond, 1928, 1932.
Evermann and Goldsborough, 1907.
Griffiths and Yoeman, 1940.
Haig-Brown, 1939.
Hartman, 1956.
Holmes and Stott, 1960.
Jordan, 1891a, 1907.
Jordan and Evermann, 1902.
Mason, 1953.
Merriman, 1935.
Neave, 1949.
Needham and Gard, 1959.
Oien, 1957.
Qadri, 1959.
Schultz, 1941.
Smith, S. B., 1955.
Suckley, 1874.
Sumner, 1948, 1953, 1962.
Vernon and McMynn, 1957.
Wales, 1957.
Weisel, 1957.
Cutthroat, Colorado River:
Cope, 1955.
Cope and Yarrow, 1875.
Drummond and Tanner, 1960.
Ellis, 1914.
Greene, 1937.
Jordan, 1891a.
Jordan and Evermann, 1902.
Jordan and Henshaw, 1879.
Platts, 1957.

Cutthroat, Colorado River—Continued
Simon, 1946.
Snyder, 1940.
Snyder and Tanner, 1960.
Tanner and Hayes, 1933.
Cutthroat, Independence Lake:
Needham and Gard, 1959.
Cutthroat, Lahontan:
Benson and Behnke, 1961.
Calhoun, 1944a, 1944b.
Calif. Div. Fish and Game, 1956.
Jordan, 1891a.
Jordan and Evermann, 1902.
Jordan and Henshaw, 1879.
Juday, 1907a.
Miller and Alcorn, 1946.
Needham and Gard, 1959.
Smith, 1947.
Snyder, 1917, 1940.
Sumner, 1940.
Wales, 1957.
Cutthroat, mountain:
Dymond, 1931, 1932.
Cutthroat, Piute:
Wales, 1957.
Cutthroat, Snake River:
Beal, 1959.
Hammer, 1960.
Rasmussen, 1960.
Wilde, 1961.
Cutthroat, Utah:
Cope, O. B., 1955.
Hatton, 1932.
Jordan, 1891a, 1920.
Jordan and Evermann, 1902.
McConnell, Clark, and Sigler, 1957.
Miller and Alcorn, 1946.
Needham and Gard, 1959.
Platts, 1957.
Tanner and Hayes, 1933.
Cutthroat, Yellowstone:
Ball, 1955.
Ball and Cope, 1961.
Bangham, 1951.
Beal, 1959.
Benson, 1958, 1960, 1961.
Biesinger, 1961.
Brown and Bailey, 1952.
Bulkley, 1961, 1963.
Bulkley and Benson, 1962.
Cope, 1953a,b, 1956, 1957a,b,c.
Drummond and Tanner, 1958b, 1960.
Dymond, 1932.
Hall, M. C., 1930.
Hazard and Madsen, 1933.
Jordan, 1891a, 1891b.
Jordan and Evermann, 1902.
Laakso and Cope, 1956.
Madsen, M., 1940.
Miller and Alcorn, 1946.
Moore, Cope, and Beckwith, 1952.
Muttkowski, 1925.
Needham and Gard, 1959.
Qadri, 1959.
Rayner, 1947.
Rich, 1924.
Schultz, 1941.
Simon, 1935, 1936, 1939, 1946, 1953, 1962.
Smith and Kendall, 1921.
Snyder, 1940.
Suckley, 1874.
Turner, 1946.
Ward, 1923.
Weisel, 1957.
Welsh, 1952.
Willoughby, 1951.
Wolf, 1954.
Wood and Dunn, 1948.
Woodbury, 1934.
DDT:
Cope, 1961.
Reed, 1963.
Schoenthal, 1963.
Development:
Merriman, 1935.
Platts, 1957.
Diet:
Davis, 1947.
Diseases:
Davis, 1947, 1953.
Fish, 1934.
Irving, 1956.
Parisot, Yasutake, and Bressler, 1963.
Post, 1959, 1962.
Rucker and Hodgeboon, 1953.
Tunison and McCay, 1933.
Wolf, 1954.
Woodbury, 1934.
Distribution:
Benson, 1961.
DeWitt, 1954a.
Dimick and Merryfield, 1945.
Dymond, 1928.
Ellis, 1914.
Evermann, 1891.
Evermann and Goldsborough, 1907.
Greene, 1937.
Hanzel, 1961.
Hazzard, 1932.
Henshall, 1902, 1906.
Jordan, 1928.
Juday, 1907a.
Kendall, 1915.
Land, 1913.

Mason, 1953.
Miller, R. R., 1950.
Mottley, 1934.
Rounsefell, 1962.
Schultz, 1941.
Simon, 1946.
Snyder, 1940.
Wales, 1957.
Ecology:
Echo, 1956.
Irving, 1953.
Eggs:
Ball and Cope, 1961.
Barrett, 1951.
Beal, 1959.
Cope, 1957b.
Cramer, 1940.
Foster, 1933.
Irving, 1956.
Leach, 1939.
Lord, 1930.
Merriman, 1935.
Rounsefell, 1957, 1962.
Rucker, Conrad, and Dickeson, 1960.
Smith, 1941.
Welsh, 1952.
Wood and Dunn, 1948.
Environment:
Gard, 1953.
Mason, 1953.
Equilibrium yield:
Bulkley, 1961.
Evolution:
Miller and Alcorn, 1946.
Mottley, 1954.
Needham and Behnke, 1962.
Excretory tissue:
Holmes and Stott, 1960a,b.
Exploitation:
Bilton, 1952.
Bilton and Shepard, 1955.
Bjornn, 1957.
Cope, 1953, 1957a.
Irving, 1956.
McConnell, Clark, and Sigler, 1957.
Miller, 1957b.
Feeding:
Benson, 1961.
Biesinger, 1961.
Brown and Buck, 1939.
Cope and Yarrow, 1875.
Dimick and Merryfield, 1945.
Donaldson and Foster, 1938.
Juday, 1907a.
Muttkowski, 1925.
Robertson, 1947.
Fertility:
Barrett, 1951.
Fertilization:
Rucker, Conrad, and Dickeson, 1960.
Fish Lake, Utah:
Hildebrand and Towers, 1927.
Food:
Bachman, 1958.
Bean, 1894a.
Bulkley, 1959.
Calhoun, 1944b.
Chapman and Quistorff, 1938.
Cope and Yarrow, 1875.
Dimick and Mote, 1934.
Echo, 1956.
Fleener, 1952.
Griffiths and Yoeman, 1940.
Hazzard and Madsen, 1933.
Hildebrand and Towers, 1927.
Huey, 1956.
Irving, 1956.
Jeppson and Platts, 1959.
Juday, 1907b.
Kemmerer, Bovard, and Boorman, 1924.
Muttkowski, 1925.
Platts, 1959b.
Reed, 1963.
Woodbury, 1934.
Furunculosis:
Post, 1959, 1962.
Gallatin River, Mont.:
Purkett, 1951.
Gas-bubble disease:
Rucker and Hodgeboom, 1953.
Genetics:
Miller, 1957b.
Glacier Park:
Hazzard and Madsen, 1933.
Schultz, 1941.
Glycogen:
Hochachka, 1961.
Hochachka and Sinclair, 1962.
Grand Teton National Park:
Hazzard, 1932.
Growth:
Bonham and Williams, 1948.
Bulkley, 1959, 1961.
Echo, 1956.
Fleener, 1952.
Hartman, 1956.
Irving, 1956.
Laakso and Cope, 1956.
Leach, 1939.
Madsen, 1940.
Pechacek, 1956.
Platts, 1958.

Growth—Continued
Purkett, 1951.
Robertson, 1947.
Sumner, 1962.
Tryon, 1943.
Willoughby, 1951.
Habits:
Bean, 1894a.
Haig-Brown, 1939.
Henshall, 1902, 1906.
Jordan and Evermann, 1902.
Juday, 1907a.
Neave, 1949.
Handling:
Black and Barrett, 1957.
Hayden Lake, Idaho:
Jeppson and Platts, 1959.
Kemmerer, Bovard, and Boorman, 1924.
Heenan Lake, Calif.:
Calhoun, 1944b.
Calif. Dept. Fish and Game, 1956.
Hemoglobin:
Hochachka, 1963.
Henrys Lake, Idaho:
Irving, 1953, 1956.
Hermaphroditism:
Benson, 1958.
Turner, 1946.
Homing:
Ball, 1955.
Platts, 1959a.
Hybrid:
Donaldson, Hansler, and Buckridge, 1957.
Dymond, 1932.
Hartman, 1956.
Madsen, D., 1936.
Miller, 1957b.
Miller and Alcorn, 1946.
Needham and Gard, 1959.
Rounsefell, 1962.
Simon, 1946.
Hyoid teeth:
Bulkley, 1963.
Ichthyophthiriasis:
Johnson, 1961.
Idaho:
Bachman, 1958.
Beal, 1959.
Bjornn, 1957, 1958, 1961.
Irving, 1953, 1956.
Jeppson and Platts, 1959.
Kemmerer, Bovard, and Boorman, 1924.
McConnell, Clark, and Sigler, 1957.
Oien, 1957.
Illustrations:
Dymond, 1932.
Evermann and Goldsborough, 1907.
Fish, 1934.
Simon, 1946.
Smith, 1941.
Immatures:
Ball and Cope, 1961.
Benson, 1960.
Infectious pancreatic necrosis:
Parisot, Yasutake, and Bressler, 1963.
Intermountain region:
Locke, 1929.
Jackson Lake:
Hazzard, 1932.
Hazzard and Madsen, 1933.
Lactic acid:
Black and Barrett, 1957.
Miller, 1958.
Lahontan system:
Snyder, 1917.
Lake Tahoe:
Benson and Behnke, 1961.
Juday, 1907a.
Lakelse Lake, British Columbia:
Bilton, 1952.
Bilton and Shepard, 1955.
Leech:
Cope, 1958b.
Lengths:
Bulkley, 1959, 1961.
Cope, 1953b, 1957b.
Irving, 1953, 1956.
Rasmussen, D. H., 1956.
Lengths, conversion factors:
Cope, 1953b.
Length-weight:
Bachman, 1958.
Bonham and Williams, 1948.
Fleener, 1952.
Irving, 1953.
Madsen, 1940.
Rasmussen, D. H., 1956.
Welsh, 1952.
Life history:
Bjornn, 1957, 1958.
Carlander, 1950, 1953.
Cope and Yarrow, 1875.
DeWitt, 1954a.
Foster, 1933.
Hagen, 1958.
Haig-Brown, 1939.
Hazzard, 1932.
McConnell, Clark, and Sigler, 1957.
Neave, 1949.
Platts, 1957.
Snyder, 1940.
Suckley, 1874.
Sumner, 1948.
Yarrow, 1875.

Light:
Benson, 1960.
Limnology:
Benson, 1961.
Logan River, Utah:
Fleener, 1952.
Pechacek, 1950.
Logging:
Bachman, 1958.
Oien, 1957.
Wustenberg, 1954.
Management:
Beal, 1959.
Biesinger, 1961.
Dymond, 1928.
Madsen, D., 1936.
Miller, 1955.
Marking:
Progressive Fish-Culturist, 1952.
Migration:
Ball and Cope, 1961.
Benson, 1960.
Bjornn, 1957.
Bulkley, 1959.
Cope, 1956, 1957b.
Cramer, 1940.
Dimick and Merryfield, 1945.
Dymond, 1932.
Haig-Brown, 1939.
Mason, 1953.
Snyder, 1917.
Snyder and Tanner, 1960.
Sumner, 1948, 1953, 1962.
Welsh, 1952.
Montana:
Echo, 1956.
Evermann, 1893.
Hanzel, 1961.
Henshall, 1906.
Purkett, 1951.
Schoenthal, 1963.
Schultz, 1941.
Tryon, 1943.
Whitney and Spindler, 1959.
Morphology:
Code, 1950.
DeWitt, 1954a.
Dymond, 1932.
Gard, 1953.
Gilbert and Evermann, 1894.
Qadri, 1959.
Snyder, 1940.
Suckley, 1874.
Vernon and McMynn, 1957.
Mortality:
Ball and Cope, 1961.
Johnson and Brice, 1952, 1953.
Miller, 1958.
Platts, 1959a.
Movement:
Ball, 1955.
Benson, 1961.
Cope and Yarrow, 1875.
Jordan, 1907.
Miller, 1954a.
Neave, 1949.
Needham and Cramer, 1943.
Platts, 1959a.
Yarrow, 1874, 1875.
Wyatt, 1959.
Nevada:
Cope and Yarrow, 1875.
Jordan and Henshaw, 1879.
Miller and Alcorn, 1946.
Sumner, 1940.
Snyder, 1917.
New Mexico:
Cope and Yarrow, 1875.
Gee, 1941, 1942.
Huey, 1956.
Huey and Wolfrum, 1956.
Miller, 1950.
North America:
Kendall, 1920.
Mason, 1953.
Rounsefell, 1957, 1962.
Suckley, 1874.
Northwestern United States:
Kemmerer, et al., 1924.
Schultz, 1934.
Nutrition:
Tunison and McCay, 1933.
Oregon:
Cramer, 1940.
Dimick and Merryfield, 1945.
Dimick and Mote, 1934.
Griffin, 1938.
Griffiths and Yoeman, 1940.
Johnson and Brice, 1952, 1953.
Jordan, 1907.
Progressive Fish-Culturist, 1952.
Rayner, 1947.
Schneider and Phillips, 1943.
Schultz, 1936.
Sumner, 1948, 1953, 1962.
Wustenberg, 1954.
Wyatt, 1959.
Ovarian fluid:
Rucker, Conrad, and Dickeson, 1960.
Overfishing:
Bjornn, 1958.
Pacific Coast:
Jordan, 1907.

Parasites:
Bangham, 1951.
Bangham and Adams, 1954.
Davis, 1947, 1953.
Hall, M. C., 1930.
Jordan, 1891b.
Kendall, 1915.
Leach, 1923, 1939.
Linton, 1891a,b, 1893.
Simon, 1935, 1939, 1953.
Woodbury, 1934.
Pathology:
Rucker, Yasutake, and Wolf, 1961.
Payette Lake, Idaho:
Kemmerer, Bovard, and Boorman, 1924.
Pelicans:
Ball and Cope, 1961.
Hall, E. R., 1925.
Hall, M. C., 1930.
Rich, 1924.
Ward, 1923.
Pend Oreille Lake, Idaho:
Kemmerer, Bovard, and Boorman, 1924.
Plankton:
Benson, 1961.
Pollution:
Dimick and Merryfield, 1945.
Pautzke, 1938.
Whitney and Spindler, 1959.
Population density:
Miller, 1957b.
Predation:
Ball and Cope, 1961.
Hall, 1925.
Rich, 1924.
Ricker, 1941.
Simon, 1939, 1953.
Priest Lake, Idaho:
Bjornn, 1957, 1958, 1961.
Kemmerer, Bovard, and Boorman, 1924.
Production:
Benson, 1960.
Cope, 1957a.
DeWitt, 1954b.
Drummond and Tanner, 1960.
Griffiths and Yoeman, 1940.
Schneider and Griffiths, 1943.
Smith, 1947.
Pyloric caeca:
Hartman, 1956.
Rounsefell, 1962.
Pyramid Lake, Nevada:
Hall, 1925.
Snyder, 1917.
Sumner, 1940.
Pyridylmercuric acetate:
Hammer, 1960.
Races:
Cope, 1957b.
Dimick and Merryfield, 1945.
Donaldson, Hansler, and Buckridge, 1957.
Reproduction:
Bulkley, 1959.
Snyder and Tanner, 1960.
Wyatt, 1959.
Respiration:
Holmes and Stott, 1960a,b.
Rhabdomyosarcoma:
Adami, 1908.
Rio Grande River:
Jordan, 1920.
Rocky Mountains:
Hagen, 1958.
Henshall, 1902.
Madsen, D., 1936.
Rasmussen, D. I., 1941.
Weisel, 1957.
Wilde, 1961.
Rogue River, Oreg.:
Griffin, 1938.
Salmo clarki alpestris:
See Cutthroat, mountain.
Salmo bouvieri:
See Trout, Waha Lake.
Salmo brevicauda:
Suckley, 1874.
Salmo clarki clarki:
See Cutthroat, coastal.
Salmo clarki henshawi:
See Cutthroat, Lahontan.
Salmo clarki lewisi:
See Cutthroat, Yellowstone.
Salmo clarki macdonaldi:
See Trout, yellow-finned.
Salmo clarki selenirus:
See Cutthroat, Piute.
Salmo clarki stomias:
See Trout, green-backed.
Salmo evermanni:
Benson and Behnke, 1961.
Gard, 1953.
Salmo gibbsi:
Hazzard and Madsen, 1933.
Suckley, 1874.
Salmo mykiss:
See Trout, red-throated.
Salmo pleuriticus:
See Cutthroat, Colorado River.
Salmo seleniris:
Snyder, 1940.
Salmo spilurus:
See Trout, Rio Grande.
Salmo stellatus:
Suckley, 1874.

Salmo tsuppitch:
See Trout, black.
Salmo virginalis:
See Trout, red-throated.
Sand Creek, Oregon:
Sumner, 1948, 1953, 1962.
Santa Fe National Forest:
Gee, 1941.
Scales:
Hartman, 1956.
Laakso, 1955.
Laakso and Cope, 1956.
Neave, 1936, 1943.
Needham and Gard, 1959.
Qadri, 1959.
Rounsefell, 1962.
Vernon and McMynn, 1957.
Scale formation:
Brown and Bailey, 1952.
Laakso and Cope, 1956.
Neave, 1936, 1943.
Sediment:
Cordone and Kelley, 1961.
Griffin, 1938.
Sex ratio:
Ball and Cope, 1961.
Bulkley, 1959.
Hartman, 1956.
Irving, 1953, 1956.
Madsen, M., 1940.
Snyder and Tanner, 1960.
Sumner, 1953.
Welsh, 1952.
Sheep Creek, Utah:
Code, 1950.
Shiner, redside:
Biesinger, 1961.
Shocking:
Morris, 1950.
Snake River:
Bangham, 1951.
Jordan, 1890.
Rasmussen, D. H., 1956, 1960.
Soils:
Benson, 1961.
Spawning:
Ball and Cope, 1961.
Calhoun, 1944a.
Cope, 1957c.
Cope and Yarrow, 1875.
Cramer, 1940.
Dimick and Merryfield, 1945.
Drummond and Tanner, 1960.
Dymond, 1932.
Foster, 1933.
Hazzard, 1932.
Juday, 1907a.
Leach, 1939.
Mason, 1953.
Neave, 1949.
Platts, 1957.
Smith, 1941.
Snyder and Tanner, 1960.
Sumner, 1948.
Weisel, 1957.
Yarrow, 1874, 1875.
Wood and Dunn, 1948.
Speciation:
Jordan, 1928.
Sperm:
Barrett, 1951.
Rucker, Conrad, and Dickeson, 1960.
Spirit Lake, Idaho:
Kemmerer, Bovard, and Boorman, 1924.
Spotting:
Bulkley, 1963.
Stocking:
Beal, 1959.
Bjornn, 1957.
Calhoun, 1944a.
Gee, 1942.
Madsen, 1936.
Miller, 1952.
Schneider and Phillips, 1943.
Thompson, R. B., 1959.
Strawberry Reservoir, Utah:
Hazzard and Madsen, 1933.
Platts, 1958, 1959b.
Sucker, longnose:
Biesinger, 1961.
Survival:
Miller, 1952, 1954b, 1955, 1958.
Snyder and Tanner, 1960.
Welsh, 1952.
Tagging:
Ball, 1955.
Ball and Cope, 1961.
Miller, 1957a.
Pechacek, 1956.
Territory:
Miller, 1957a.
Thompson Lake, Mont.:
Echo, 1956.
Toxicity:
Hammer, 1960.
Trapper's Lake:
Drummond and Tanner, 1960.
Tricaine methanesulfonate:
Thompson, R. B., 1959.
Trout, black:
Jordan and Henshaw, 1879.
Suckley, 1874.
Trout, Clark's:
See Trout, red-throated.

Trout, green-backed :
Bulkley, 1959.
Ellis, 1914.
Greene, 1937.
Jordan, 1891a.
Jordan and Evermann, 1902.
Land, 1913.
Simon, 1946.
Trout, red-throated :
Bean, 1894a.
Cope and Yarrow, 1875.
Evermann, 1893.
Jordan, 1890, 1891a, 1891b, 1920.
Kendall, 1920.
Linton, 1891a, b, 1893.
Suckley, 1874.
Yarrow, 1874, 1875.
Trout, Rio Grande :
Cope and Yarrow, 1875.
Ellis, 1914.
Greene, 1937.
Jordan, 1891a, 1920.
Land, 1913.
Trout, Rocky Mountain :
See Trout, red-throated.
Trout, Waha Lake :
Jordan, 1891a.
Trout, yellow-finned :
Ellis, 1914.
Greene, 1937.
Jordan, 1891a.
Jordan and Evermann, 1902.
Trypan Blue :
Progressive Fish-Culturist, 1952.
Tumor :
Adami, 1908.
Twin Lakes, Colo. :
Juday, 1907b.
Two-Ocean Pass, Wyo. :
Daniels, 1952.
Jordan, 1928.
Upper Blue Lake, Calif. :
Calhoun, 1944a,b.
Upper Pecos River, N. Mex. :
Gee, 1941.
Utah :
Cope, 1955.
Cope and Yarrow, 1875.
Fleener, 1952.
Foster, 1933.
Hatton, 1932.
Jordan, 1891a.
Laakso, 1955.
Lord, 1930.
McConnell, Clark, and Sigler, 1957.
Pechacek, 1950.
Platts, 1957, 1958, 1959b.
Tanner, 1936.
Tanner and Hayes, 1933.
Yarrow, 1874.
Utah Lake :
Hatton, 1932.
Yarrow, 1874.
Vertebrae :
Hartman, 1956.
Mottley, 1937.
Needham and Gard, 1959.
Qadri, 1959.
Rounsefell, 1962.
Viability :
Hartman, 1956.
Washington :
Chapman and Quistorff, 1938.
Pautzke, 1938.
Schultz, 1936.
Thompson, R. B., 1959.
Water levels :
Benson, 1960.
Bulkley and Benson, 1962.
Water quality :
Benson, 1961.
Western United States :
DeWitt, 1954b.
Miller, 1950.
Willamette River :
Dimick and Merryfield, 1945.
Wind River Range, Wyoming :
Robertson, 1947.
Winterkill :
Rasmussen, 1960.
Wyoming (not including Yellowstone) :
Beal, 1959.
Evermann, 1893.
Grasse, 1949.
Hazzard, 1932.
Jordan, 1928.
Pechacek, 1956.
Rasmussen, D. H., 1956.
Robertson, 1947.
Simon, 1946.
Wilde, 1961.
Year-class :
Benson, 1960.
Bulkley, 1961.
Bulkley and Benson, 1962.
Yellowstone Lake :
Ball, 1955.
Ball and Cope, 1961.
Bangham, 1951.
Benson, 1958, 1960, 1961.
Biesinger, 1961.
Brown and Bailey, 1952.
Bulkley, 1961, 1963.
Bulkley and Benson, 1962.

Cope, 1953a,b, 1956, 1957a,b,c, 1958b.
Hall, M. C., 1930.
Jordan, 1890, 1891b.
Kendall, 1915.
Laakso, 1956.
Laakso and Cope, 1956.
Linton, 1891a,b, 1893.
Madsen, M., 1940.
Moore, Cope, and Beckwith, 1952.
Muttkowski, 1925, 1929.
Rich, 1924.
Simon, 1935, 1936, 1939, 1946, 1953, 1962.
Smith and Kendall, 1921.
Turner, 1946.
Ward, 1923.
Welsh, 1952.
Willoughby, 1951.
Wood and Dunn, 1948.
Woodbury, 1934.
Yellowstone River:
Ball and Cope, 1961.
Cope, 1961.
Zinc:
Slater, 1961.

Created by act of Congress in 1849, the Department of the Interior is responsible for a wide variety of programs concerned with the management, conservation, and wise development of America's natural resources. For this reason it often is described as a Department of Conservation.

Through a score of bureaus and offices the Department has responsibility for the use and management of millions of acres of federally owned lands; administers mining and mineral leasing on a sizable area of additional lands; irrigates reclaimed lands in the West; manages giant hydroelectric power systems; administers grazing and forestry programs on federally owned range and commercial forest lands; protects fish and wildlife resources; provides for conservation and development of outdoor recreation opportunities on a nationwide scale; conserves hundreds of vital scenic, historic, and park areas; conducts geologic research and surveys; encourages mineral exploration and conducts mineral research; promotes mine safety; conducts saline water research; administers oil import programs; operates helium plants and the Alaska Railroad; is responsible for the welfare of many thousands of people in the territories of the United States; and exercises trusteeship for the well-being of additional hundreds of thousands of Indians, Aleuts, and Eskimos, as well as being charged with resource management of millions of acres of Indian-owned lands.

In its assigned function as the Nation's principal natural resource agency, the Department of the Interior bears a special obligation to assure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America, now and in the future.